CONNECTICUT RIVER BASIN

WINCHESTER, CONNECTICUT

CRYSTAL LAKE DAM
CT 00104

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

AUGUST, 1979

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/er program reads: Phase I Inspection Report, National Dam Inspection Program; vever, the official title of the program is: National Program for Inspection of 1-Federal Dams; use cover date for date of report.

EY WORDS (Continue on reverse side if necessary and identify by block number)

AMS, INSPECTION, DAM SAFETY,
Conn. River Basin
Winchester, Conn.
Crystal Lake Dam

BSTRACT (Continue on reverse side if necessary and identify by block number)

is an earthfill embankment with a concrete and masonry spillway at the central of the dam. A new highway embankment for Route 263 was constructed in 1976 just m from the dam. The old road is now used as an access to the dam and lies ow the crest and extends along the dam from the right abutment to the llway. The dam is approx. 520 ft. long and 8+ ft. wide at the crest, which is 14 above the streambed of Sucker Brook. The spillway consists of a 45 ft. long broad sted concrete weir and a concrete apron which is just below the weir and enclosed masonry training walls.

407-1113

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF NEDED

FEB 14 1980

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor Grasso:

Inclosed is a copy of the Crystal Lake Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, the town of Winchester.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

CONNECTICUT RIVER BASIN
WINCHESTER, CONNECTICUT

CRYSTAL LAKE DAM
CT 00104

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST, 1979

BRIEF ASSESSMENT

PHASE I INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Name of Dam:	CRYSTAL LAKE DAM
Inventory Number:	00104
State Located:	CONNECTICUT
County Located:	LITCHFIELD
Town Located:	WINCHESTER
Stream:	SUCKER BROOK
Owner:	TOWN OF WINCHESTER
Date of Inspection:	MAY 3, 1979
Inspection Team:	PETER M. HEYNEN, P.E.
	MIRON PETROVSKY
	GEORGE STEPHENS
	JAY COSTELLO

The dam is an earthfill embankment with a concrete and masonry spillway at the central part of the dam. A new highway embankment for Route 263 was constructed in 1976 just downstream from the dam. The old road is now used as an access to the dam and lies just below the crest and extends along the dam from the right abutment to the spillway (See Sheet B-1). The dam is approximately 520 feet long and 8± feet wide at the crest, which is 14 feet above the streambed of Sucker Brook. The spillway consists of a 45 foot long broad-crested concrete weir and a concrete apron which is just below the weir and enclosed by masonry training walls. This apron funnels the water into a 60 inch asphalt coated corrugated metal pipe (ACCMP) through the new highway embankment.

Based upon the visual inspection at the site and past performance, the dam is judged to be in fair condition. No evidence of structural instability was observed, however there are areas requiring attention such as seepage on the right toe of the dam, spalling of the spillway weir and wet areas and lime deposits on the masonry training walls.

In accordance with Corps of Engineers Guidelines for the size (Intermediate) and hazard (Significant) classifications of the dam, the test flood will be equivalent to one-half the Probable Maximum Flood (PMF). Peak inflow to the reservoir is 1250 cfs; peak outflow is 550 cfs with the dam overtopped 0.1 feet.

The spillway capacity is 410 cfs., which is equivalent to 75% of the routed test flood outflow. The hydraulic/hydrologic calculations do not include the effects of the Route 263 highway embankment and 60 inch culvert.

It is recommended that the owner retain the services of a registered professional engineer to perform a detailed hydraulic/hydrologic analysis to determine the adequacy of the project discharge. This analysis should consider the potential for the highway embankment to impound water and the possibility that the 60 inch culvert does not have adequate capacity to discharge the test flood outflow. Also, should the embankment have impoundment capabilities, a breach analysis of the embankment should be done considering the impact area and the downstream hazard classification. Recommendations should then be made by the engineer and implemented by the owner. Attention should also be focused on more complete maintenance, seepage problems in the embankment and repair of the spillway.

The above recommendations and any further remedial measures which are discussed in section 7, should be instituted within one (1) year of the owner's receipt of this report.

Peter M. Heynen, P.E.
Project Manager
Cahn Engineers, Inc.

STATE OF CONNECTICUT
PETER M. HEYNEN
NO. 9618
REGISTERED
PROFESSIONAL ENGINEER

Edgar B. Vinal, Jr., P.E.
Senior Vice President
Cahn Engineers, Inc.

STATE OF CONNECTICUT
EDGAR B. VINAL, JR.
No. 4198
REGISTERED
PROFESSIONAL ENGINEER

This Phase I Inspection Report on Crystal Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

Joseph W. Finegan

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam would necessarily represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as neccessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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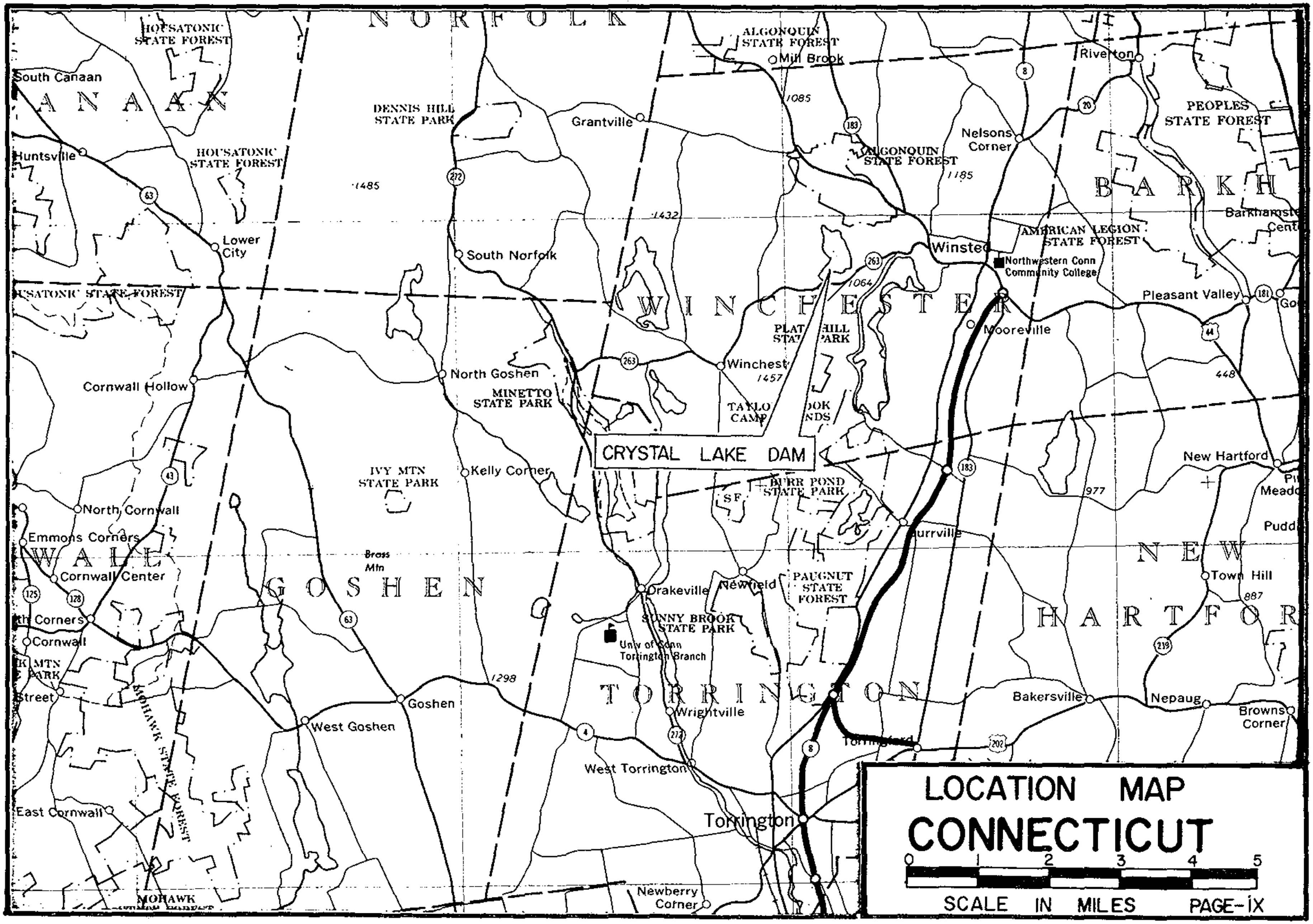
OVERVIEW PHOTO
(March 1979)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	CRYSTAL LAKE DAM	WINCHESTER	DATE ~~AUG 79~~
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER		SUCKER BROOK	CONNECTICUT	CE # 27 660 KC PAGE viii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Riverton
PEOPLES STATE FOREST
Nelsons Corner
ALGONQUIN STATE FOREST
BARKH
Lower City
South Norfolk
Winsted
AMERICAN LEGION STATE FOREST
Northwestern Conn Community College
Pleasant Valley
WINCHESTER
Mooreville
PLATT HILL STATE PARK
North Goshen
Winchester
MINETTO STATE PARK
Cornwall Hollow
CRYSTAL LAKE DAM
New Hartford
IVY MTN STATE PARK
Kelly Corner
BURR POND STATE PARK
North Cornwall
Emmons Corners
Burrville
GOSHEN
NEW
Cornwall Center
Drakeville
Newfield
PAUGNUT STATE FOREST
Town Hill
SUNNY BROOK STATE PARK
HARTFORD
Univ of Conn Torrington Branch
Cornwall
Goshen
TORRINGTON
Bakersville
Nepaug
West Goshen
Wrightville
Browns Corner
West Torrington
MOHAWK STATE FOREST
East Cornwall
Torrington
Newberry Corner
MOHAWK
LOCATION MAP
CONNECTICUT
0 1 2 3 4 5
SCALE IN MILES

PHASE I INSPECTION REPORT

CRYSTAL LAKE DAM

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of March 30, 1979 from John P. Chandler Colonel, Corps of Engineers. Contract No. DACW 33-79-C-0059 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program - The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

2. Encourage and prepare the States to guickly initiate effective dam inspection programs for non-federal dam.

3. To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program - The scope of this Phase I inspection report includes:

1. Gathering, reviewing and presenting all available data as can be obtained from the owners, previous owners, the state and other associated parties.

2. A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.

3. Computations concerning the hydraulics and hydrology of the facility and its relationship to the calculated flood through the existing spillway.

4. An assessment of the condition of the facility and corrective measures required.

It should be noted that this report does not pass judgement on the safety or stability of the dam other than on a visual basis. The inspection is to identify those features of the dam which need corrective action and/or further study.

1.2 DESCRIPTION OF PROJECT

a. Location - The dam is located on Sucker Brook in a rural area of the Town of Winchester, County of Litchfield, State of Connecticut. The dam is shown on the Winsted USGS Quadrangle Map having coordinates latitude N 41°55.0' and longitude W 73°06.3'.

b. Description of Dam and Appurtenances - The dam, built in 1892, is an earthfill embankment with a concrete and masonry spillway. The dam is 520± feet long and is 8± feet wide at the crest which is 14 feet above the streambed of Sucker Brook. The top elevation varies and is 1021.5± at the left side of the spillway and slopes up from elevation 1021.5± at the right spillway wall to 1024.5± at the right abutment.

An old road, now used as an access, extends from the right abutment to the spillway. The embankment for this road forms the downstream slope and is inclined at 2 horizontal to 1 vertical. A new highway embankment was built for Route 263 just downstream from the dam in 1976. The north slope of the embankment for the new Route 263 and the southern slope of the access road form a swale which extends along the dam to the spillway. At the spillway, the highway embankment begins to encroach upon the crest and eliminate the swale. At the left abutment, the highway embankment slopes directly to the crest of the dam. (See Sheet B-1)

The upstream slope of the dam is inclined at 3 horizontal to 1 vertical and has a riprap protection. The crest is covered with grass and has a 6 foot chain link fence extending the length of the dam and around the spillway structure. The spillway consists of a concrete broad-crested weir and a concrete apron. The apron is set approximately 8 feet below the weir crest and slopes down to a 60 inch asphalt coated corrugated metal pipe (ACCMP) through the highway embankment. Masonry training walls are on either side of the apron and abut the concrete wingwalls of the pipe inlet structure.

c. Size Classification - Intermediate - The dam impounds 1400 acre-feet of water with the level at the top of the dam, which at elevation 1021.5±, is 14 feet above the streambed. According to Recommended Guidelines, a dam with a storage of this capacity is classified as intermediate in size.

d. Hazard Classification - Significant - The dam is located 2700± upstream from a house which is 6± feet above a small pond in the channel of Sucker Brook.

e. Ownership - Town of Winchester
Mr. Dennis Moore
Town Manager
(203) 379-2713

f. Operator - Mr. Frank Kane
Director of Public works
(203) 379-4101

g. Purpose of Dam - Water supply

h. Design and Construction History - The following information is believed to be accurate based on the plans and correspondence available. The original dam was built in 1892 and the embankment for the access road was probably added later. The bridge over the spillway was removed and a 60 inch corrugated metal pipe with a concrete intake structure abutted to the old masonry retaining walls was added in 1976 when the new Route 263 was constructed. A drainage system including a catch basin, 15 inch and 18 inch reinforced concrete pipes and a drainage ditch was also added at this time. (See Sheet B-1)

i. Normal Operational Procedures - There are no regulating outlets at the dam, but water is drawn from the reservoir through a 24 inch supply line to Winsted, Conn. Approximately 2 million gallons per day are drawn from the lake as reported by the operator. Water can be diverted through a 6' by 6' rock tunnel from Rugg Brook Reservoir to Crystal Lake, however the City of Winsted has no record of the quantity of flows that are diverted through this tunnel. During high flows on Rugg Brook, the gates in the tunnel are closed because of vegetation and discoloration in the runoff.

1.3 PERTINENT DATA

a. Drainage Area - 1.10 square miles of relatively undeveloped rolling terrain.

b. Discharge at Damsite - Discharge is from the spillway to the 60 inch ACCMP through the highway embankment. Water is also drawn off through a 24 inch water supply line at an intake structure located upstream and separate from the dam.

1. Outlet Works:

   24 inch supply line — 2 mgd for water supply

   60 inch ACCMP at Invert El. 1008± — 300 cfs at test flood

2. Maximum known flood @ damsite: — Unknown

3. Ungated spillway capacity @ top of dam el. 1021.5±: — 410 cfs.

4. Ungated spillway capacity @ test flood el. 1021.6±: — 440 cfs.

5. Gated spillway capacity @ normal pool el.: — N/A

6. Gated spillway capacity @ test flood el.: — N/A

7. Total spillway capacity @ test flood el. 1021.6±: — 440 cfs

8. Total project discharge @ test flood el. 1021.6±: — 550 cfs.

c. Elevations (Feet Above Mean Sea Level)

1. Streambed @ centerline of dam: — 1008±

2. Maximum tailwater: — N/A

3. Upstream portal invert diversion tunnel: — Unknown

4. Recreation pool: — N/A

5. Full flood control pool: — N/A

6. Spillway crest (ungated): — 1019.5±

7. Design surcharge (original design): — Unknown

8. Top of dam: — 1021.5±

9. Test flood surcharge: — 1021.6±

10. Highway embankment: — 1027.8± (lowest elevation downstream of dam)

d. Reservoir

1. Length of maximum pool: 4500
2. Length of recreation pool: N/A
3. Length of flood control pool: N/A

e. Storage

1. Recreation pool: N/A
2. Flood control pool: N/A
3. Spillway crest pool: 1400 acre-ft.
4. Top of dam: 1680 acre-ft.
5. Test flood pool: 1700 acre-ft.

f. Reservoir Surface

1. Recreation pool: N/A
2. Flood control pool: N/A
3. Spillway crest: 135 acres
4. Top of dam: 145 acres
5. Test Flood Pool: 160 acres

g. Dam

1. Type: Earthfill Embankment
2. Length: 520± ft.
3. Height: 14± ft.
4. Top width: 8± ft.
5. Side slopes: 3H to 1V Upstream
2H to 1V Downstream
6. zoning: N/A
7. Impervious core: Unknown
8. Cutoff: N/A
9. Grout curtain: N/A

10. Other: Earthfill highway embankment

h. <u>Diversion Tunnel</u>

1. Type: 6'x6' unlined rock tunnel from Rugg Brook Reservoir

2. Length: 3600± ft.

3. Closure: N/A

4. Access: N/A

5. Regulating facilities: Gated at upstream tunnel entrance

i. <u>Spillway</u>

1. Type: Broad-crested concrete weir

2. Length of weir: 45± ft.

3. Crest el.: 1019.5±

4. Gates: N/A

5. Upstream channel: Natural lake bottom

6. Downstream Channel: 60" ACCMP through highway embankment to natural channel

7. General: Concrete apron below weir feeds pipe through embankment

j. <u>Regulating Outlets</u> - N/A

SECTION 2: ENGINEERING DATA

2.1 DESIGN

a. Available Data - There was no available data for the original construction of the dam. Data for the diversion tunnel was obtained from "Sucker Brook Design Memorandum No. 1". Highway plans for Route 263 were available from the State of Connecticut Department of Transportation.

b. Design Features - The available data indicates the design features stated herein.

c. Design Data - There were no engineering values, assumptions, test results or calculations available for the original design. Data was available for the 60 inch ACCMP through the highway embankment as listed in Appendix B.

2.2 CONSTRUCTION

a. Available Data - No information was available for the construction of the dam, however as-built drawings were available for the present configuration of Route 263.

b. Construction Considerations - No information was available except for the above mentioned drawings obtained from the Connecticut Department of Transportation.

2.3 OPERATIONS

No formal operation records are known to exist but it is reported that the dam was overtopped in the flood of August 1955.

2.4 EVALUATION

a. Availability - Existing data was provided by the State of Connecticut Department of Transportation and the Department of Environmental Protection. The owner made the facility available for visual inspection.

b. Adequacy - The amount of detailed engineering data available was generally inadequate to perform in in-depth assessment of the dam, therefore, this assessment of the dam must be based primarily on visual inspection, performance history, hydraulic computations and approximate hydrologic judgements.

c. Validity - A comparison of records data and visual observations reveals no observable significant discrepancies in the record data.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The general condition of the dam is fair. Inspection did reveal areas requiring maintenance and monitoring. The reservoir level was 1019.4±, 2.1 feet below the top of the dam at the time of our inspection.

b. Dam - The dam is an earthfill embankment with a concrete and masonry spillway at the central part of the dam.

Crest - The crest of the dam has a grass cover (Photos 1, 2, and 3). No misalignments, cracks or depressions were observed. Several large trees were noted on the crest of the embankment to the left of the spillway.

Upstream Slope - The slope protection is riprap and a grass cover at the crest. No erosion or sloughing was observed, however trees of 4 to 6 inches in diameter were noted (Photo 1).

Downstream Slope - The slope protection is grass. At the right side of the spillway, between the access road embankment and the Route 263 embankment there is a swale which slopes toward a catch basin near the spillway. The swale drains into a 15 inch reinforced concrete pipe (RCP) which drains into the catch basin. An 18 inch reinforced concrete pipe (RCP) extends from the catch basin to the spillway and outlets at the right concrete wingwall (See Sheet B-1).

No erosion or cracks were observed on the downstream slope of the embankment. There is an extensive wet area along the downstream slope near the right abutment approximately 5 to 6 feet below the crest, with a total seepage flow from this area to the swale of approximately 5 to 10 gallons per minute (Photo 3). There was some brown silt deposits at the outlet of the 18 inch RCP exiting at the right spillway wingwall (Photo 3).

Spillway - The 45 foot long and 8 foot wide ungated spillway is a concrete structure with a concrete apron, concrete dissipators and stone masonry training walls. Deterioration of the concrete with spalling and exposed aggregate was observed on the downstream face of the spillway weir and the spillway apron (Photos 1 and 2). Lime deposits and wet areas on the mortar joints were noted on both training walls (Photos 2 and 4).

c. Appurtenant Structures - The appurtenant structure is a 60 inch asphalt coated corrugated metal pipe extending from the spillway apron through the Route 263 embankment, with concrete headwalls on both slopes of the embankment. The pipe and concrete headwalls, constructed three years ago, were in good condtion.

d. Reservoir Area - The shoreline surrounding the pond is heavily wooded and largely undeveloped.

e. Downstream Channel - The downstream channel is the 60 inch ACCMP to the streambed of Sucker Brook which is mostly undeveloped and wooded to the initial impact area.

3.2 EVALUATION

Based upon the visual inspection, the dam was assessed as being generally in fair condition. The following features which could influence the future condition and/or stability of the dam were identified.

1. Increase in seepage through the embankment could lead to development of erosion and sloughing along the dam toe.

2. Brush and trees on the crest and slopes of the dam could increase seepage in the dam and could cause damage if trees overturn during strong winds and hurricane conditions.

SECTION 4: OPERATIONAL PROCEDURES

4.1 REGULATING PROCEDURES

There is no formal schedule for lake level readings. The 24 inch supply line is upstream from the dam and is open at the lake and controlled at a downstream chlorination facility.

4.2 MAINTENANCE OF DAM

Maintenance consists of cutting the brush and grass once a month.

4.3 MAINTENANCE OF OPERATING FACILITIES

There are no regulating facilities located at the dam.

4.4 DESCRIPTION OF ANY FORMAL WARNING SYSTEM IN EFFECT

The dam is patrolled three times a week. A representative of the town of Winchester is at the site during heavy storms to monitor conditions.

4.5 EVALUATION

The maintenance procedures are generally good. The trees on the upstream slope and crest should be removed.

A formal program of operation and maintenance procedures should be implemented, including documentation to provide complete records for future reference. Remedial operation and maintenance recommendations are presented in Section 7. Also, a more formal warning system should be developed and implemented within the time frame indicated in Section 7.1c.

SECTION 5: HYDRAULICS/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. General - Crystal Lake Dam is generally a low surcharge storage - high spillage water supply facility. A diversion tunnel from Rugg Brook Reservoir enters Crystal Lake in the northwest corner and according to the operator can be controlled by gates at the tunnel inlet. During periods of flooding, the flow in the diversion was found to be an insignificant part of the Sucker Brook inflow, so will not be considered for the purposes of our computations.

A highway embankment for Route 263 is located 50± feet downstream from the dam. In response to correspondence with the Corps of Engineers and their subsequent recommendations, the highway embankment and the discharge capacity of the 60 inch culvert was not considered in the computations for spillway adequacy. Additional information is given in Appendix D-3. However, it is noted that the highway culvert does not have adequate capacity to discharge the test flood outflow and results in a backwater condition that overtops the dam by 1.7± feet.

b. Design Data - No computations could be found for the original construction of the dam.

c. Experience Data - No information on serious problems situations arising at the dam were found. However, the dam was overtopped during the August, 1955 flood.

d. Visual Observations - Water flowing over the spillway is funneled into a 60 inch ACCMP through the highway embankment by a concrete headwall and wingwalls abutted with the old masonry training walls.

e. Test Flood Analysis - The test flood for this significant hazard, intermediate size dam is equivalent to one-half the Probable Maximum flood (PMF) or 1250 cubic feet per second (cfs) based upon "Preliminary Guidance for Estimating Maximum Probable Discharge", dated March, 1978. Peak outflow is 550 cfs with the dam overtopped 0.1 feet (Appendix D-5). Based upon our hydraulic computations, the spillway capacity is 410 cfs which is approximately 75% of the routed Test Flood outflow.

f. Dam Failure Analysis - Utilizing the April, 1978, "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs", the peak outflow before failure of the dam would be approximately 400 cfs and the peak failure outflow from the dam breaching would be 8300 cubic feet per second. A breach of the dam would result in a rise of 7.2 feet in the water level of the stream at the initial impact area 2700 feet downstream from the dam. This corresponds to an increase in the water level from a depth of 3.4 feet just before the breach, to a depth of 10.6 feet just after the breach. The rapid 7.2 foot increase in the water level at the initial impact area would inundate 1 house to a depth of 1.5± feet. Further flooding downstream of the intital impact area would be controlled by the Sucker Brook Dam.

The highway embankment was not considered in the failure analysis of the dam. However, it should be noted that failure of the dam probably will not occur until failure of the highway embankment. This is due to the additional structural support to the dam from the highway embankment and the large differential head resulting from rapid drawdown downstream of the dam upon failure of the highway embankment.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Inspection - The visual inspection did not reveal any indications of stability problems. There is a seep with an extensive wet area on the downstream slope near the right abutment. Trees on the crest and slopes of the dam could lead to seepage and stability problems if not removed.

b. Design and Construction Data - There is not enough design and construction data to permit an in-depth assessment of the structural stability of the dam.

c. Operating Records - The operating records available do not include any indications of dam instability since its construction in 1892.

d. Post Construction Changes - The post-construction changes are only the installation of a 60 inch culvert under the realigned Route 263, constructed in 1976.

e. Seismic Stability - The dam is in Seismic Zone 1 and according to the Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition - Based upon the visual inspection of the site and its past performance, the dam appears to be in fair condition. No evidence of structural instability was observed in the dam or its appurtenances. The embankment is generally in fair condition with substantial seepage on the downstream slope near the right abutment. Other areas of concern are the trees on the dam crest and slopes, concrete of the spillway and the spillway capacity.

Based upon "Preliminary guidance for Estimating Maximum Probable discharge" dated March, 1978, peak inflow to the reservoir is 1250 cfs; peak outflow is 550 cfs with the dam overtopped. Based upon our hydraulic computations, the spillway capacity is 410 cfs, which is equivalent to approximately 75% of the routed test flood outflow.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the dam must be based solely on visual inspection, past performance of the dam, and sound engineering judgement.

c. Urgency - It is recommended that the measures presented in sections 7.2 and 7.3 be implemented within one (1) year of the owner's receipt of this report.

d. Need for Additional Information - There is a need for more information as recommended in section 7.2

7.2 RECOMMENDATIONS

a. It is recommended that further studies be made by a registered professional engineer qualified in dam design and inspection pertaining to the following:

1. A more detailed hydraulic/hydrologic analysis to determine the adequacy of the project discharge. This analysis should consider the potential for the highway embankment to impound water and the possibility that the 60 inch culvert does not have adequate capacity to discharge the test flood outflow. Also, should the embankment have impoundment capabilities, a breach analysis of the embankment should be done considering the impact area and the downstream hazard classification. Recommendations should be made by the engineer and implemented by the owner.

2. Inspection of the dam in warm and cold seasons, and during times of high and low head to determine seepage problems and make any necessary recommendations. Items of particular importance are as follows:

a. Origin and significance of seepage at the downstream slope near the right abutment and brown silt deposits from the 18 inch storm pipe.

b. Removing the large trees from the dam crest and slopes and filling of the holes should be undertaken under supervision of the engineer.

7.3 REMEDIAL MEASURES

a. Operation and Maintenance Procedures - The following measures should be undertaken within the time frame indicated in section 7.1.c, and continued on a regular basis.

1. Round-the-clock surveillance should be provided by the owner during periods of unusually heavy precipitation or high project discharge. The owner should develop a downstream warning system in case of emergencies at the dam.

2. A formal program of operation and maintenance procedures should be instituted and fully documented to provide accurate records for future reference.

3. A program of inspection by a registered, professional engineer qualified in dam inspection should be instituted on an annual basis. The inspections should be comprehensive in nature.

4. Seepage at the downstream slope near the right abutment should be monitored periodically for measurement of flow rate.

5. Deteriorating concrete of the spillway weir and apron should be repaired.

6. All obstructions on the spillway apron including logs and stones should be removed.

7. Small trees and brush on the crest, the upstream and downstream slopes and the toe of the dam should be removed. The cutting of grass on the dam should be continued as part of the routine dam maintenance.

7.4 ALTERNATIVES

This study has identified no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT Crystal Lake Dam

DATE: May 3, 1979

TIME: 9:30 P.M.

WEATHER: Sunny, 75°F

W.S. ELEV. 1019.4± U.S. ______ DN.S

PARTY:	INITIALS:	DISCIPLINE:
1. Peter M. Heynen	PMH	Cahn Engineers, Inc.
2. Miron Petrovsky	MP	Cahn Engineers, Inc.
3. George Stephens	GS	Cahn Engineers, Inc.
4.		
5.		
6.		

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Earthfill Embankment	PMH, MP, GS	
2. Concrete Spillway	PMH, MP, GS	
3. Culvert	PMH, MP, GS	
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

PERIODIC INSPECTION CHECK LIST

Page A-2

PROJECT Crystal Lake Dam DATE May 3, 1979

PROJECT FEATURE Earthfill Embankment BY PMH, MP, GS

AREA EVALUATED		CONDITION
EMBANKMENT		
st Elevation		1021.5±
rent Pool Elevation		1019.4±
imum Impoundment to Date		Unknown
face Cracks		None observed
ement Condition		Old road on crest, good condition
ement or Settlement of Crest		None observed
eral Movement		
tical Alignment		Appears good
izontal Alignment		
dition at Abutment and at Concrete uctures		
lications of Movement of Structural ms on Slopes		None observed
spassing on Slopes		Some
ughing or Erosion of Slopes or tments		None observed
k Slope Protection-Riprap Failures		Unknown
sual Movement or Cracking at or r Toes		None observed
sual Embankment or Downstream page		Seepage and wet area at d/s slope near right abutment
ing or Boils		None observed
ndation Drainage Features		Unknown
Drains		drainage ditch, 15" and 18" R.C.P., and catch basin
trumentation System		N/A

PERIODIC INSPECTION CHECK LIST

Page A-3

PROJECT Crystal Lake Dam | DATE May 3, 1979

PROJECT FEATURE Culvert | BY PMH, MP, GS

AREA EVALUATED		CONDITION
LET WORKS-TRANSITION AND CONDUIT		60" ACCMP (with concrete head-walls) under Route 263
eral Condition of Concrete		Good
t or Staining on Concrete		None observed
lling		None observed
sion or Cavitation		None observed
cking		None observed
gnment of Monoliths		N/A
gnment of Joints		N/A
bering of Monoliths		N/A

PERIODIC INSPECTION CHECK LIST

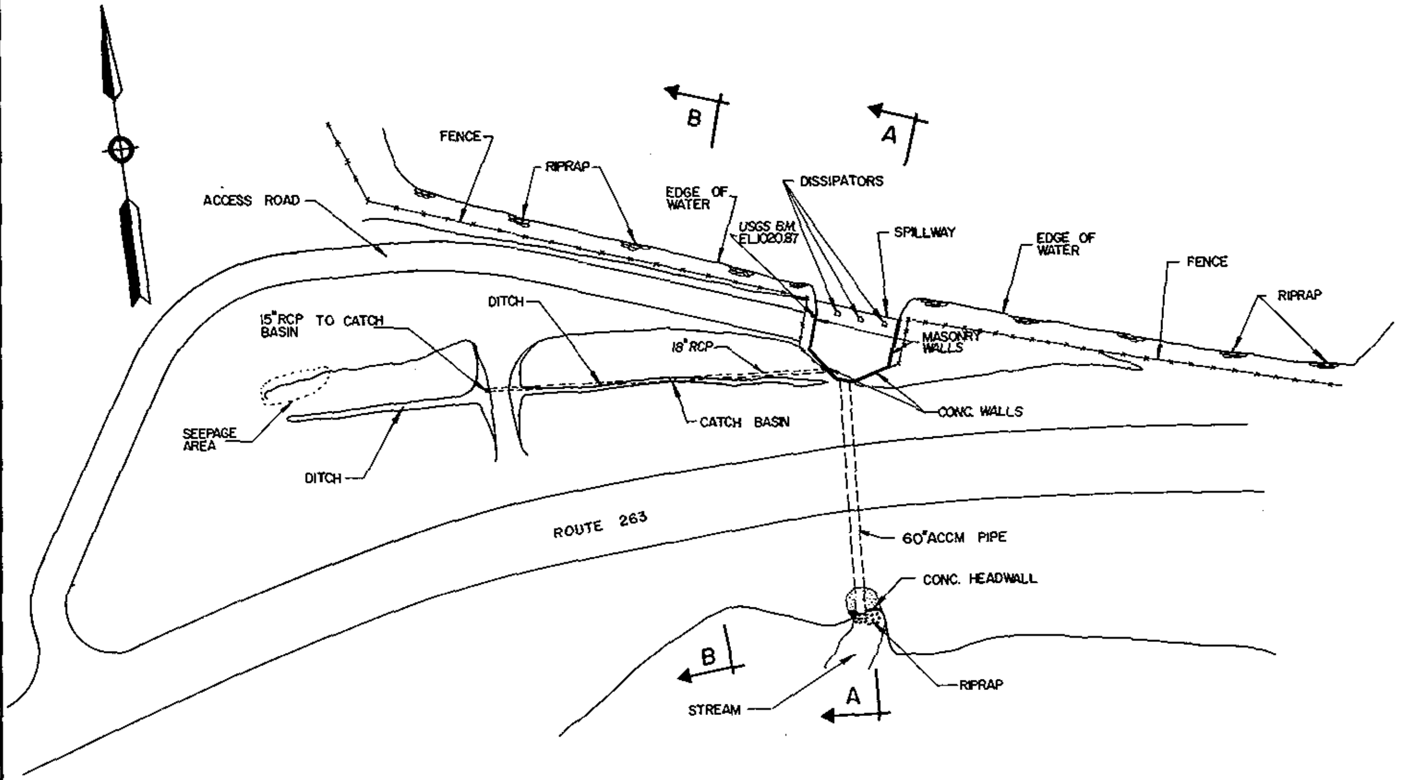
PROJECT Crystal Lake Dam DATE May 3, 1979

PROJECT FEATURE Concrete Spillway BY PMH, MP, GS

AREA EVALUATED		CONDITION
TLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS		
Approach Channel		
General Condition		Appears good
Loose Rock Overhanging Channel		None observed
Trees Overhanging Channel		None observed
Floor of Approach Channel		Under water
Weir and Training Walls		Concrete weir & apron and masonry training walls
General Condition of Concrete		Fair
Rust or Staining		None observed
Spalling		Some, on crest & d/s face of weir
Any Visible Reinforcing		None observed
Any Seepage of Efflorescence		Wet joints & lime deposits on training walls
Drain Holes		N/A
Discharge Channel		
General Condition		Fair
Loose Rock Overhanging Channel		None observed
Trees Overhanging Channel		Some
Floor of Channel		Old stream
Other Obstructions		None

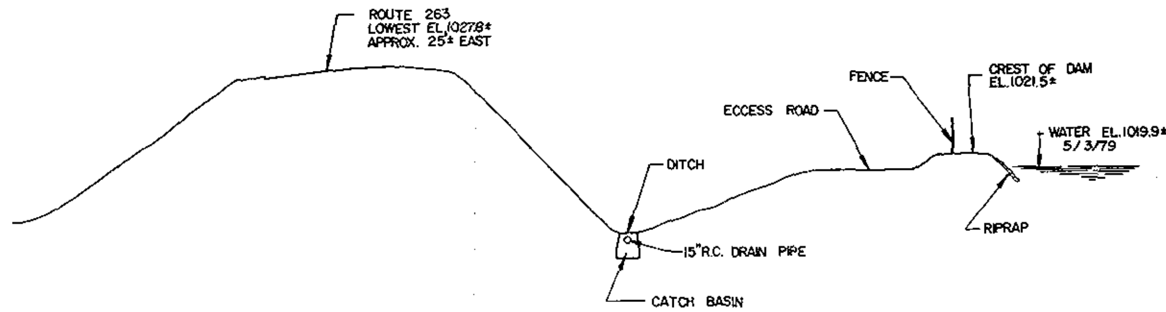
APPENDIX B

ENGINEERING DATA AND CORRESPONDENCE



PLAN

50 0 50 100



SECTION B-B

HORIZONTAL 20 0 20 40

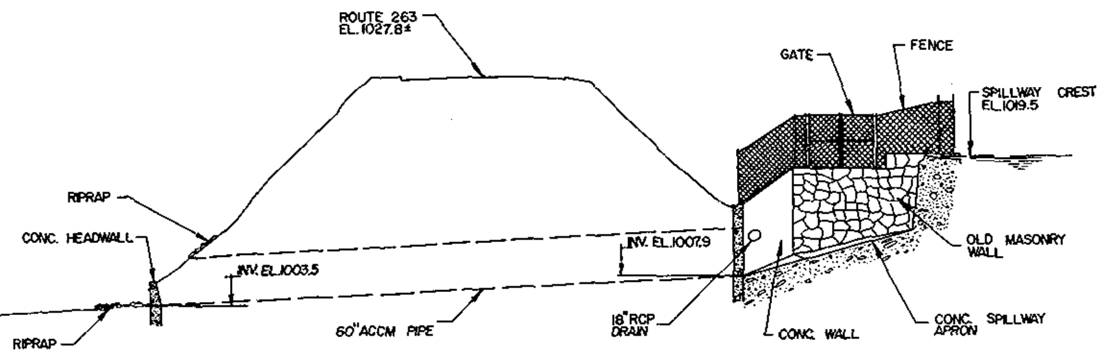
VERTICAL 10 0 10 20

NOTES

1. THIS PLAN WAS COMPILED FROM CONNECTICUT DEPARTMENT OF TRANSPORTATION HIGHWAY PLANS, PROJECT NUMBER 162-93, DATED 1976 AND ADDITIONAL DATA FROM CAHN ENGINEERS.

   NOT ALL STRUCTURAL AND/OR TOPOGRAPHIC FEATURES ARE NECESSARILY IDENTIFIED.

2. ELEVATION SHOWN ARE MEAN SEA LEVEL ELEVATION AS REFERENCED TO A USGS BENCH MARK LOCATED AT THE N.W. CORNER OF THE OLD SPILLWAY BRIDGE ABUTMENT, ELEVATION 1020.87.



SECTION A-A

HORIZONTAL 20 0 20 40

VERTICAL 10 0 10 20

CAHN ENGINEERS INC. WALLINGFORD CONNECTICUT ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PLAN & SECTIONS

CRYSTAL LAKE DAM

TR- SUCKER BROOK WINCHESTER, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE: AS NOTED	
N.N.	JMC	AnH	DATE: AUGUST 1979	SHEET B-1

CRYSTAL LAKE DAM

Existing Plans

"Replacement of Bridge and Approaches
over Sucker Brook on Route 263"
Project Number 162-93
Connecticut Department of Transportation (1976)

SUMMARY OF DATA AND CORRESPONDENCE

Date	To	From	Subject	Page
June, 1964	Files	U.S. Army Engineer Division New England Corps of Engineers	Excerpt from "Sucker Brook Dam and Reservoir Design Memorandum No. 1 (Pgs. 9, 10, 15)	B-3
March 8, 1974	Mr. H. F. Monnier	James C. Spencer	Computation of discharge through Route 263 embankment	B-6
August 18, 1975	Mr. John A. Stock Design Engineer Bureau of Highways	John T. Wells, Chief Hydraulics and Drainage Bureau of Highways	Recommendation for 60" ACCMP and Water surfaces though pipe	B-7
June 15, 1979	Mr. Peter Heynen Chief Geotechnical Engineer Cahn Engineers, Inc.	George H. Hubbard Chief of Design Bureau of Highways	Correspondence concerning Hydraulic Computations	B-9
Aug. 15, 1979	Files	Robert Jahn Cahn Engineers, Inc.	Transcription of notes for Topographic Survey	B-10

In general, the volume of runoff experienced in the 1955 floods has demonstrated that it is desirable to provide at least eight inches of storage whenever feasible. On this basis the authorization for Sucker Brook dam provided for a flood control reservoir with 8.0 inches of storage from a drainage area of 3.4 square miles which established a spillway crest elevation of 926 feet msl.

During the current design of the dam, the location of the center line was moved upstream from the original location to take advantage of more favorable topography. This change in the dam site, combined with a recent and more detailed topographic survey of the reservoir area, indicated that it was necessary to raise the spillway crest nearly 9 feet to elevation 934.7 to obtain the authorized 8.0 inches of storage. The spillway crest elevation was established at 935.0 feet msl giving a storage capacity of 8.1 inches from the drainage area of 3.43 square miles.

7. CITY OF WINSTED WATER SUPPLY

The city of Winsted uses the water in Crystal Lake for water supply purposes. To augment flows into the lake, a gated 6' x 6' unlined rock tunnel about 3,400 feet in length was excavated through a mountain to divert water from Rugg Brook Reservoir to Crystal Lake by gravity flow. The normal head differential between the reservoir and the lake is about 13 feet. Assuming an "n" coefficient of .04, it is estimated that the maximum discharge through the tunnel is in the range of 100 cfs. A canal about 2,300 feet in length was also constructed to divert Mad River flows into Rugg Brook Reservoir.

The city of Winsted has no record of the flows that are diverted from Mad River to Rugg Brook or to Crystal Lake. However, the city has the right to divert all flows from Mad River through the canal to Rugg Brook Reservoir. Releases from Rugg Brook Reservoir are accomplished by diversion through the aqueduct or over the spillway back into Mad River.

During periods of high flow on Mad River and Rugg Brook the Winsted Water Works Department has found it necessary to close the gates to the aqueduct tunnel because of the large amounts of vegetation and discoloration in the runoff.

The water supply diversion into Crystal Lake during periods of moderate or large floods was investigated to determine if it affected the spillway design criteria of the proposed dam. However the rate of diversion was found to represent a very small percentage of the Sucker Brook inflow and could be neglected for design purposes.

A 24-inch water line from Crystal Lake supplies water to the city of Winsted. Highland Lake has been developed for recreational activities and is not used for water supply. No water supply storage is contemplated at Sucker Brook dam. Following is a tabulation of the Winsted water consumption for the following years:

Water Year	Yearly Consumption (gallons)	Average Monthly (mgd)
1960	585,400,000	1.63
1961	614,000,000	1.68
1962	608,000,000	1.67
1963	688,900,000	1.88* (max. rate in July-2.22 mgd)

* Maximum rate of 2.22 mgd = 3.5 cfs/day for Winsted

8. UNIT HYDROGRAPH ANALYSIS

a. General. There is no stream gaging station on Sucker Brook or comparable drainage area in the Mad River watershed. However discharge records are available for a small drainage area about 12 miles northwest of the proposed dam site, namely, Valley Brook near West Hartland, Connecticut (DA = 7.2 square miles). These records were reviewed and found satisfactory for unit hydrograph analysis. A review of the Burlington Brook discharge records gave unsatisfactory results for unit hydrograph analysis.

Unit hydrographs had previously been derived for Leadmine Brook (DA = 24 square miles), a tributary of the Naugatuck River. These unit hydrographs were presented in the Hydrology and Hydraulic Analysis Design Memorandum for the Thomaston Dam and Reservoir, dated January 1957. A summary of Leadmine Brook unit hydrographs is shown on Plate No. 1-18.

Precipitation records were taken from several stations within or adjacent to the basin and include Torrington, Hartford, Norfolk and Barkhamsted in Connecticut and Westfield in Massachusetts. The locations of these stations are shown on Plate No. 1-1.

hour, which is consistent with minimum losses determined in previous studies for the New England area.

c. Spillway design flood inflow. The spillway design flood inflow to Sucker Brook Reservoir was derived by applying the rainfall excess values of Table 9 to the adopted unit hydrograph. The resulting hydrograph has a peak of 6,500 cfs and is shown on Plate No. 1-21.

Consideration was given to developing unit hydrographs for the area upstream of Crystal Lake (DA = 1.04 square miles) and for the net drainage area at the dam site (DA = 2.39 square miles). It is estimated that the effect of Crystal Lake on a spillway design flood would be to reduce the peak outflow by about 10 percent and to delay the peak about one hour. These changes were not considered sufficient to necessitate a refinement of the adopted unit hydrograph shown on Plate No. 1-19.

d. Failure of Crystal Lake Dam. Consideration was also given to the effect of a spillway design flood on Crystal Lake Dam. The dam has a concrete spillway with a length of about 40 feet. About 250 feet of roadway which also acts as the dam has an elevation about one foot higher than the concrete spillway, and during a large flood acts as an emergency overflow section. The roadway has no significant embankment as it was constructed on natural ground which has a gradual slope in the downstream direction. During the August 1955 flood, most of the roadway was inundated but the velocity of flow was insufficient to cause any major damage or washout.

It is estimated that during the peak of spillway design flood the Crystal Lake water surface would rise about 2½ feet (a one foot rise is equivalent to about 2.4 inches of runoff from the net area) with a corresponding depth over the road of about 1½ feet. Some localized scour may occur in the overland flow but any sudden release of a large volume of flow does not appear likely. As previously noted, maximum stages in Crystal Lake will occur after the peak flow from the downstream uncontrolled watershed, hence, any increased outflow due to erosion should not occur coincident with the maximum inflow into Sucker Brook Reservoir.

e. Spillway design flood outflow. The spillway design flood was routed through the reservoir assuming the flood control storage was initially half-full (4 inches), three-quarters full (6 inches) and full to spillway crest (8.1 inches). The results of the three routings are tabulated below:

Winchester - Route 263
Project 162-93
Sucker Brook Crossing with Route 263

March 8, 1974

Mr. H. F. Monnier

James C. Spencer

The Hydraulics and Drainage Section has computed the hydraulic requirements for the above subject project, as requested in your memorandum dated February 28, 1974.

The total drainage area to the site is 1.10 sq. mi., with 0.21 sq. mi. of the area being Crystal Lake, located just upstream of the existing bridge. Based on Soils Conservation Service method for flood routing, the estimated design discharge is 130 cfs for a 50-year frequency storm.

The required waterway area to pass the design discharge is 20 sq. ft., thus a single 60" ACCMP or twin 48" ACCMP may be used. Riprap 3.0 ft deep with 1.0 foot of gravel base should be placed for a length of 25± ft. at the outlet because of the 17 - 19 f.p.s. velocities.

JCG:scw
cc: Mr. K. F. Crawford
Mr. J. C. Guardo
Hydraulics File
Central Files

Winchester
Route 263
Project 162-93
Sucker Brook Crossing With Route 263
August 18, 1975
John T. Wells, Chief
Hydraulics and Drainage Section
Bureau of Highways

JTW

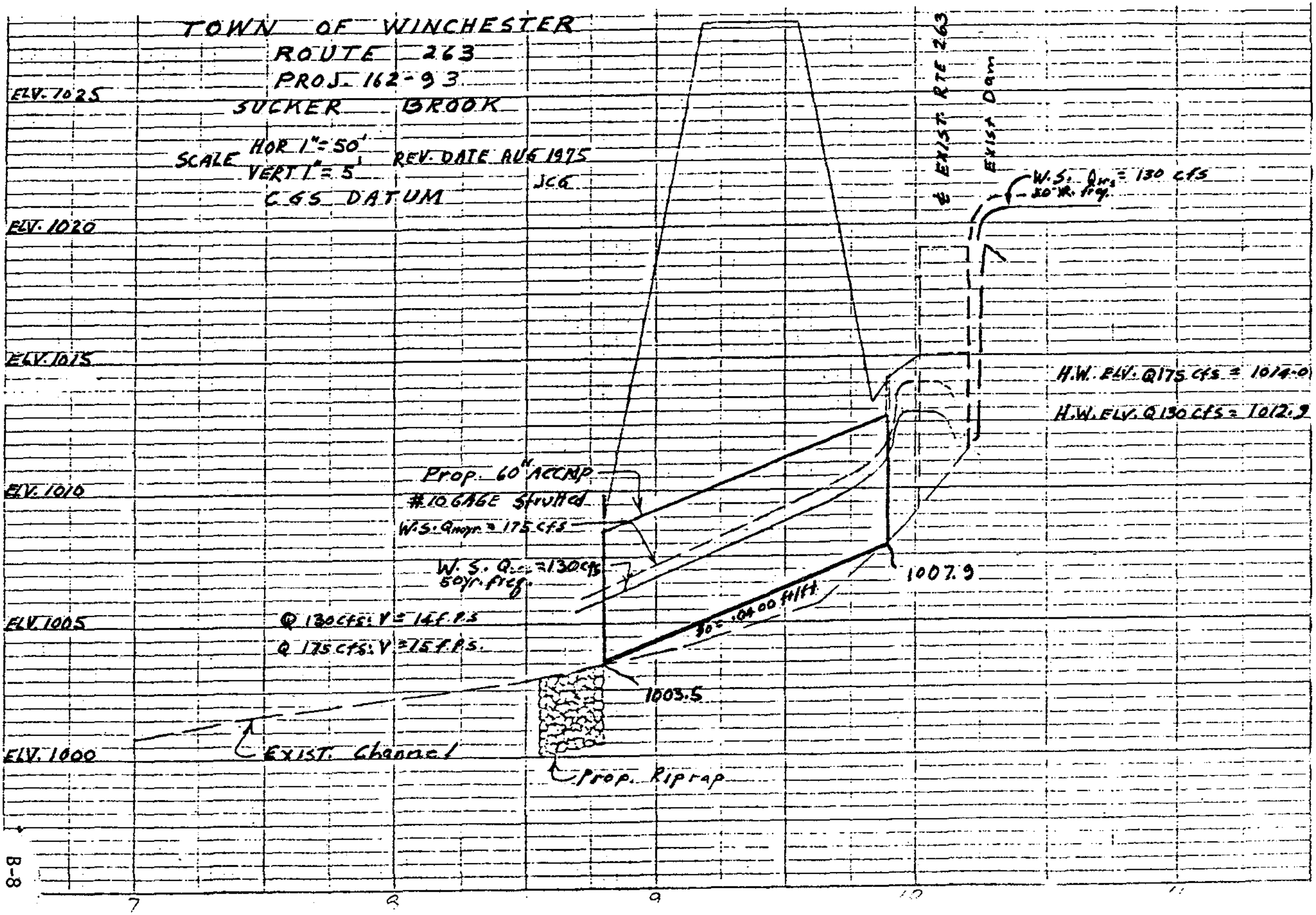
Mr. John A. Stock
Designing Engineer
Bureau of Highways

The Hydraulics and Drainage Section has reviewed the subject project as requested in your interoffice communication, dated August 13, 1975.

It is recommended that a 60" ACCMP (#10 gage strutted) be used in place of the proposed 60" R.C.P. to reduce the outlet velocity 5 feet per second to 14 feet per second at 130 cfs. The other features of the design should remain as originally proposed.

Water surfaces for 50-year and 100-year storms are shown on the attached culvert profile.

Joseph C. Guardo:scw
Attachment
cc: Karl F. Crawford
Joseph C. Guardo - Attachment
John T. Wells-Hydraulics File - "
Central Files


TOWN OF WINCHESTER
ROUTE 263
PROJ. 162-93
SUCKER BROOK
SCALE HOR 1" = 50'
VERT 1" = 5'
REV. DATE AUG 1975
JCG
C.G.S. DATUM
ELV. 1025
ELV. 1020
ELV. 1015
ELV. 1010
ELV. 1005
ELV. 1000
℄ EXIST. RTE 263
EXIST. Dam
W.S. Q_{50} = 130 cfs
50 YR. freq.
H.W. ELV. Q175 cfs = 1014.0
H.W. ELV. Q130 cfs = 1012.9
Prop. 60" ACCMP
#10 GAGE Strutted
W.S. Q_{100yr} = 175 cfs
W.S. Q = 130 cfs
50 yr. freq.
1007.9
Q 130 cfs: V = 14 f.p.s.
Q 175 cfs: V = 15 f.p.s.
S = .0400 ft/ft
1003.5
EXIST. Channel
Prop. Riprap
7
8
9
10
11

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
24 WOLCOTT HILL ROAD, P.O. DRAWER A
WETHERSFIELD, CONNECTICUT 06109

June 15, 1979

An Equal Opportunity Employer

RECEIVED
JUN 18 1979
CAHN ENG.

Mr. Peter M. Heynen, P.E.
Chief Geotechnical Engineer
Cahn Engineers, Inc.
20 Alexander Drive
Wallingford, Connecticut 06492

Dear Mr. Heynen:

Subject: Hydrology/Hydraulic Computations
Route 263 at Crystal Lake Dam
Winsted, Connecticut

This is in reply to your letter of June 7, 1979 requesting hydrology and hydraulic computations at the subject site.

Your representative, Mr. Jay Costello, called at Department of Transportation's Engineering Office in Newington on June 8, 1979 and personally obtained the requested information.

At this time we also informed Mr. Costello that prints of Project No. 162-93, Winchester, could be obtained at the Department of Transportation Administration Building, Blueprint Room, Wethersfield, Connecticut.

The hydraulic computations are based on limited investigation by the State. We will not be held liable for errors or changed conditions when this data is used by others.

Very truly yours,

George H. Hubbard

George H. Hubbard
Chief of Design
Bureau of Highways

1

AUG 15, 1979
F.S., B.J. CLOUDY, WINDY, 68° ∡'s TURNED RIGHT

CRYSTAL LAKE, WINSTED (ADDITIONAL TOPO)

π @ F-1 0° @ F-2
1 → 105.20 / π BS 5.20 BM-1 ASSUMED 100.00' = 1028.3

∡	DIST	RR	"CE"	MSL	DESC
291-22	82	14.47	90.7		EDGE OF DR. C. INTER FEN
234-24	141	13.58	91.6		" "
225-16	182	12.38	92.8		" "
217-30	235	10.29	94.4		" "
210-28	270	8.00	97.2		" "
290-42	88	13.2	92.0		TOP SLOPE - DOWNSTREAM (FENCE 2' UPSTREAM)
254-53	104	12.6	92.6		" " "
233-31	150	11.8	93.4		" " "
221-18	215	10.4	94.8		" 5' "
218-50	238	10.0	95.2		" 5' "
217-35	246	9.0	96.2		" 8' "
217-07	268	9.1	96.1		GRND.
214-08	315	6.7	98.5		"
213-05	332	0.1	105.1		"
291-48	89	12.71	92.5	1020.87	CORP ENGINEERS BM-2 1020.87
294-15	89	13.96	91.2		SPILLWAY
292-23	95	14.72	90.5		BACK OF SPILLWAY
287-24	96	12.0	93.2		TOP OF SLOPE UPSTREAM
276-04	98	12.3	92.9		" "
265-04	106	11.7	93.5		" "
247-38	129	11.6	93.6		" "
239-06	150	11.5	93.7		" "
223-55	234	11.7	93.5		" "
222-00	265	8.5	96.7		GRND
222-00	270	7.3	97.9		"
223-57	290	8.8	96.4		GRND COR FENCE
219-30	250	10.2	95.0		COR. FENCE
319-25	117	12.3	92.9 (..lcide (02.2±)		TOP OF SLOPE UPSTREAM

CE +928.37 = MSL - A.C.E

37
,63

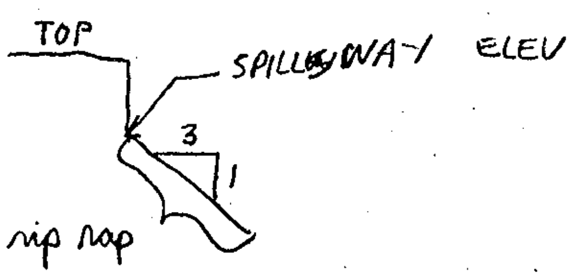
CRYSTAL LAKE (CON'T) F.S. T Ø B.T. Ø

②

T @ F-1 (CON'T)

$\overline{\text{S}}$	DIST	RE			DESC
350-43	226	11.9	93.3	left side spillway	TOP SLOPE UPSTREAM
357-04	312	9.4	95.8		" " "
359-40	332	4.3	100.9		GRND
359-11	305	5.8	99.4		GRND @ FENCE LINE UPSTREAM SIDE OF SPILLWAY
318-39	111	14.48	90.5		BOTOM OF SPILLWAY DOWNSTREAM
320-01	102	21.52	83.68		
321-00	59	25.03	80.2	(1008.5)	TOP OF RET WALL (6.7' DOWN TO INV. 5'Ø PIPE)
		24.12			TOP 5'Ø PIPE
		5.20 ✓			BM-1 CHECK

5 SLOPE OF DAM



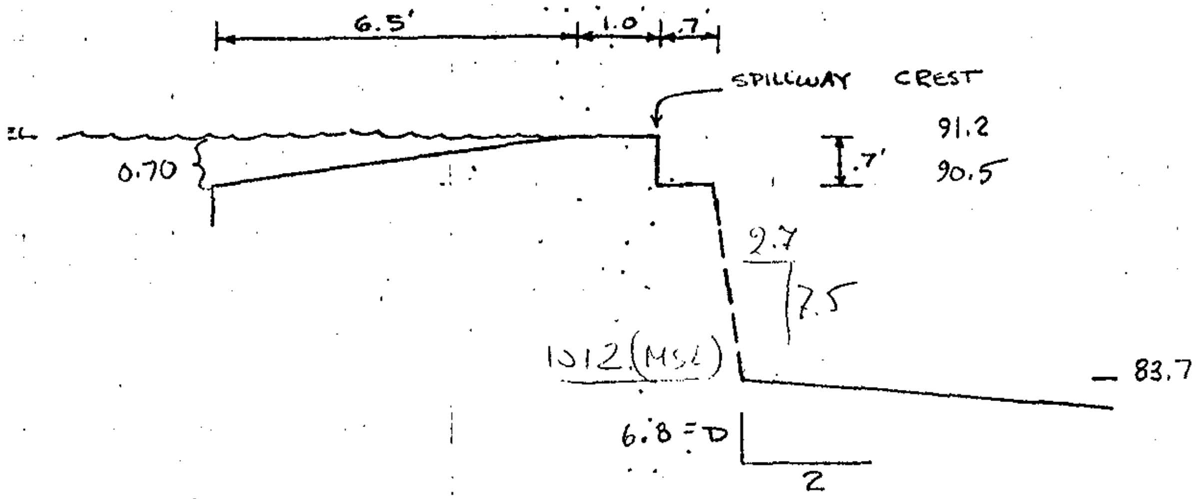
0
63
57

7.85
1.56

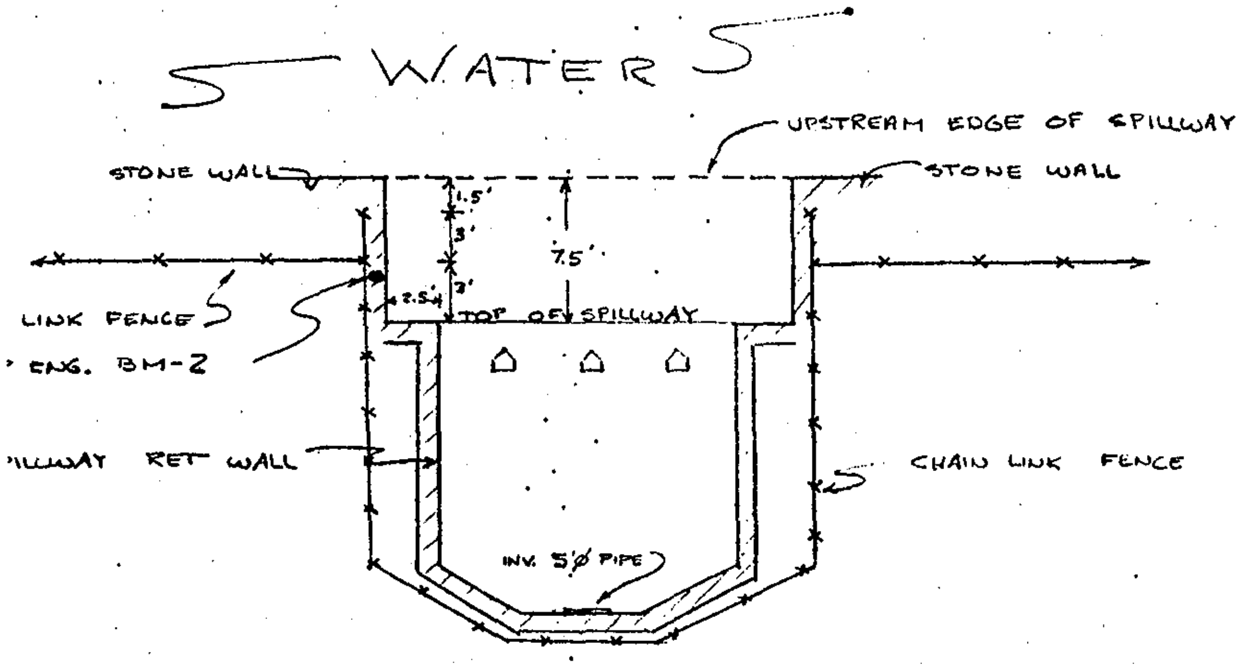
166
8

CRYSTAL LAKE

SPILLWAY X- SECTION



SPILLWAY DETAIL



APPENDIX C

DETAIL PHOTOGRAPHS

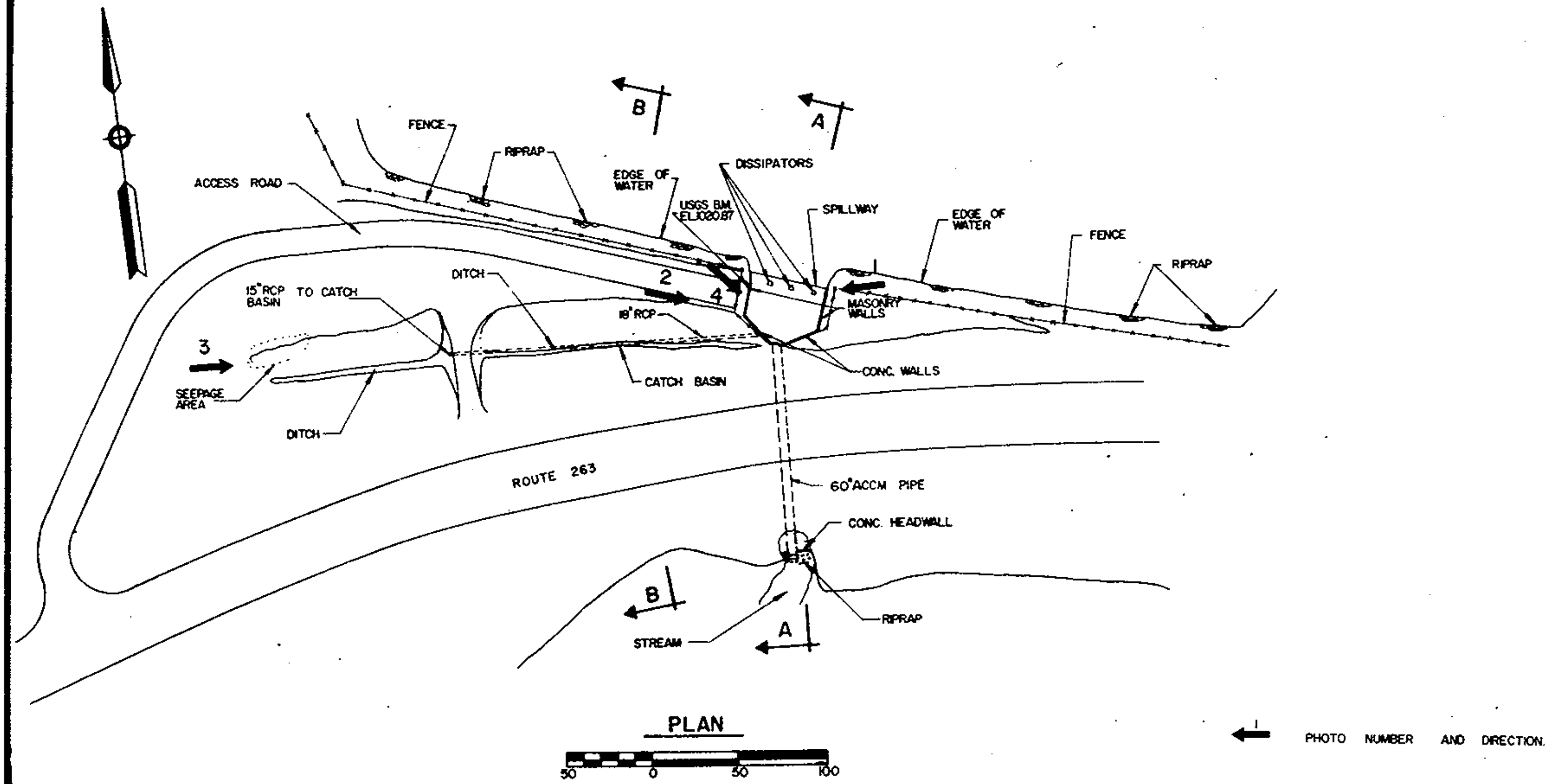


PHOTO LOCATION PLAN

CRYSTAL LAKE DAM

SHEET C-1

Photo 1 - Crest of embankment and spillway from left spillway training wall. Note trees on upstream slope of embankment and deterioration of upper right training wall (May 1979)

Photo 2 - Left embankment and spillway from right spillway training wall. Note deteriorated concrete on downstream face of spillway weir and efflorescence on left spillway training wall (May 1979)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	CRYSTAL LAKE DAM SUCKER BROOK WINCHESTER CONNECTICUT
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER		CE #27 660 KC DATE Aug 79 PAGE C-1

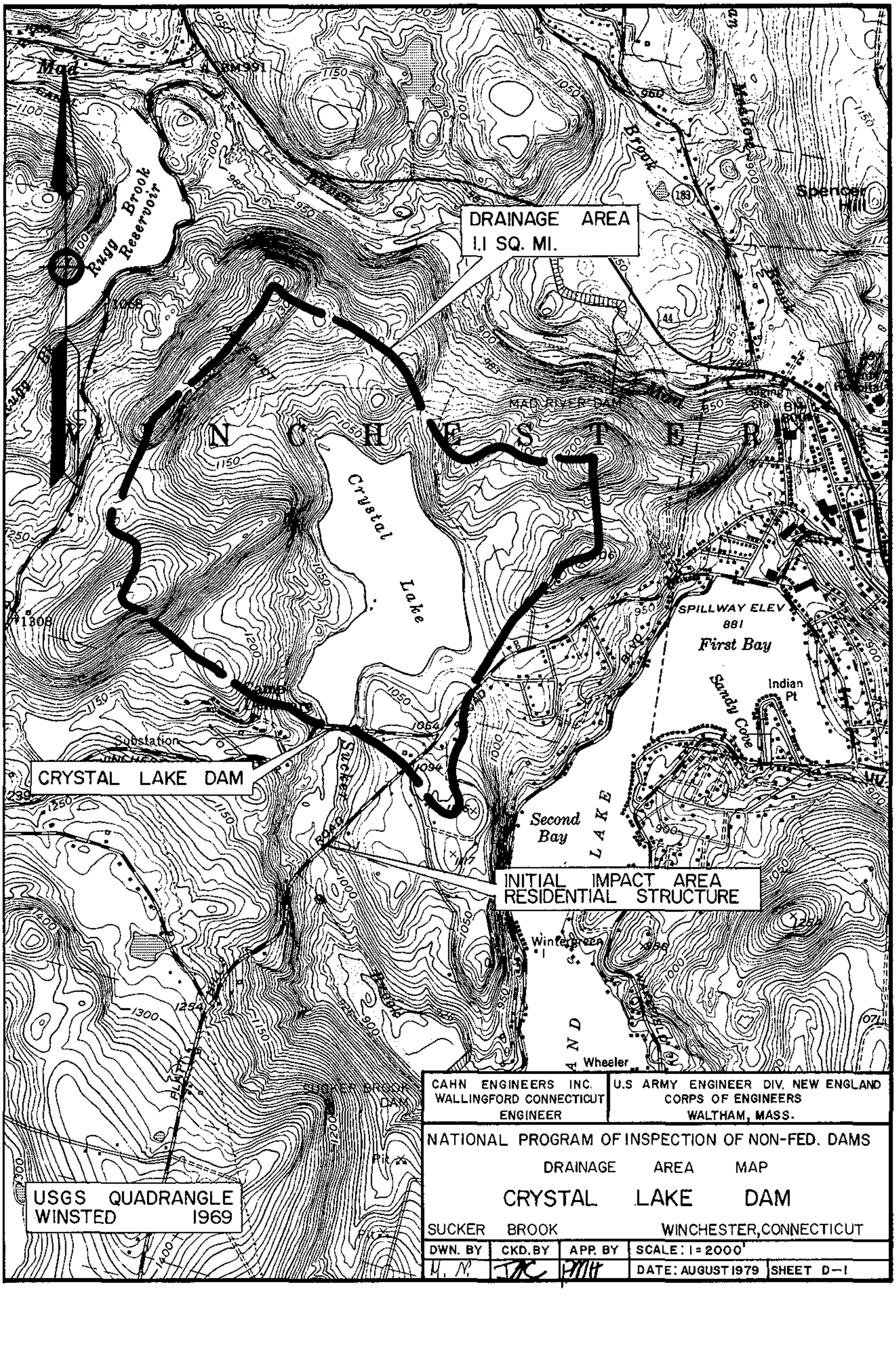
Photo 3 - Crest of right embankment and swale between dam and route 263. Note seepage from embankment (May 1979)

Photo 4 - Culvert intake, drain pipe outlet and concrete head wall from spillway apron. Note brown silt deposits from drain pipe (May 1979)

S ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	CRYSTAL LAKE DAM SUCKER BROOK WINCHESTER CONNECTICUT
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER		CE# 27 660 KC DATE Aug 79 PAGE C-2

APPENDIX D

HYDRAULICS/HYDROLOGIC COMPUTATIONS



DRAINAGE AREA
1.1 SQ. MI.
CRYSTAL LAKE DAM
INITIAL IMPACT AREA
RESIDENTIAL STRUCTURE
SPILLWAY ELEV
881
First Bay
Crystal Lake
Rugg Brook Reservoir
Mad
MAD RIVER DAM
W I N C H E S T E R
Second Bay
Sandy Cove
Indian Pt
Spencer Hill
Substation
Wintergreen
Wheeler
SUCKER BROOK DAM
Sucker
USGS QUADRANGLE
WINSTED 1969
CAHN ENGINEERS INC.
WALLINGFORD CONNECTICUT
ENGINEER
U.S ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
DRAINAGE AREA MAP
CRYSTAL LAKE DAM
SUCKER BROOK
WINCHESTER, CONNECTICUT
DWN. BY
CKD. BY
APP. BY
SCALE: 1=2000'
DATE: AUGUST 1979
SHEET D-1

HYDRAULIC/HYDROLOGIC INSPECTION
CRYSTAL LAKE DAM, WINCHESTER, CT.
I PERFORMANCE AT TEST FLOOD CONDITIONS

1) MAXIMUM PROBABLE FLOOD

a) WATERSHED CLASSIFIED AS ROLLING

b) WATERSHED AREA

SUCKER BROOK IS CROSSED OVER BY CONN. ROUTE 263 HIGHWAY EMBANKMENT (±) 50' D/S FROM CRYSTAL LAKE DAM. THE FLOW FROM THE DAM WILL RUN THROUGH A 60" DIAMETER ACCMP LOCATED IN THE EMBANKMENT. SEE PG. 9 FOR ADDITIONAL COMMENTS

CRYSTAL LAKE WATERSHED INCLUDES A GATED TUNNEL DIVERSION FROM RUGG BROOK RESERVOIR, THE MAXIMUM DISCHARGE THROUGH THE TUNNEL (6'×6', 3400' LONG) IS ESTIMATED AT 100 CFS. HOWEVER, THE TUNNEL IS CLOSED TO CRYSTAL LAKE AT HIGH FLOWS* AND THEREFORE IT WILL NOT BE CONSIDERED IN THE ANALYSIS.

i) TOTAL D.A.** 1.10 SQ. MI. (DOES NOT INCLUDE RUGG BROOK D.A.)

* REPORT TITLED "SUCKER BROOK DAM AND RESERVOIR, DESIGN MEMORANDUM No. 1, HYDROLOGY," BY ACE, JUNE 1964, PG. 9

** STATE OF CONN., ROUTE 263 REPORT, HYDRAULICS AND DRAINAGE SECTION, D.A. = 1.10 SQ. MI.; ACE REPORT, JUNE 1964, PG. 15, D.A. = 1.04 SQ. MI.

ahn Engineers Inc. Consulting Engineers

NON FEDERAL DAM INSPECTION
ed By R.R.J. Checked By [illegible] TAC
Book Ref. Other Refs. C.E. #27660 KC

Date 08/07/79
Revisions

CRYSTAL LAKE DAM

1-(CONT'D) MAXIMUM PROBABLE FLOOD

c) FROM NED-ACE "PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES" - GUIDE FOR PMF -PEAK FLOW RATES

i) PMF ≅ 2300 CFS/Sq. Mi

D) PEAK INFLOW

THE PEAK INFLOW CORRESPONDING TO THE ABOVE UNIT PMF IS AS FOLLOWS

PMF ≅ 1.10 × 2300 ≅ 2500 CFS

2) TEST FLOOD:

a) CLASSIFICATION OF DAM ACCORDING TO NED-ACE RECOMMENDED GUIDELINES

i) SIZE : STORAGE (MAX) 1700 Ac·ft (≥1000 AND <50000)
* HEIGHT 14' (25' < H < 40')

*STORAGE: CONN. PUBLIC UTILITIES COMMISSION 450 MG (1380 Ac·ft); US INVENTORY OF DAMS, 1402 Ac·Ft; WINSTED DEPT OF PUBLIC WORKS 52,143,200 gallons, 10' BELOW SPILLWAY (~160 Ac·Ft); CE USING S.A 10' BELOW SPILLWAY = 120 Ac. AND S.A at SPILLWAY CREST = 150 Ac., MAX. STORAGE = 1700 Ac-FT.
*HEIGHT: CONN D.O.T. PLANS TITLED "REPLACEMENT OF BRIDGE AND APPROACHES OVER SUCKER BROOK ON RT. 263," SHEET 10 OF 18, 1976; C.E. FIELD SURVEY, AUGUST 1979 (SEE NOTE PAGE 10)

*TEST FLOOD = ½ PMF IN LIEU OF FULL PMF. SEE TEXT, SECT. 5.1.a.

CRYSTAL LAKE DAM

2a - CONT'D) CLASSIFICATION OF DAM

(i) HAZARD POTENTIAL
CRYSTAL LAKE DAM IS LOCATED (±) 2700' U/S FROM A SMALL POND WITHIN THE SUCKER BROOK DRAINAGE CHANNEL. THERE IS ONE HOUSE LOCATED WITHIN 6' OF THE WATER SURFACE OF THE POND. CRYSTAL LAKE DAM IS LOCATED (±) 50' U/S FROM A RECONSTRUCTED PORTION OF CONN ROUTE 263.

(ii) CLASSIFICATION

SIZE : INTERMEDIATE
HAZARD: SIGNIFICANT

b) TEST FLOOD = ½ PMF = 1250 CFS PMF = 2500 CFS

3) SURCHARGE AT PEAK INFLOW

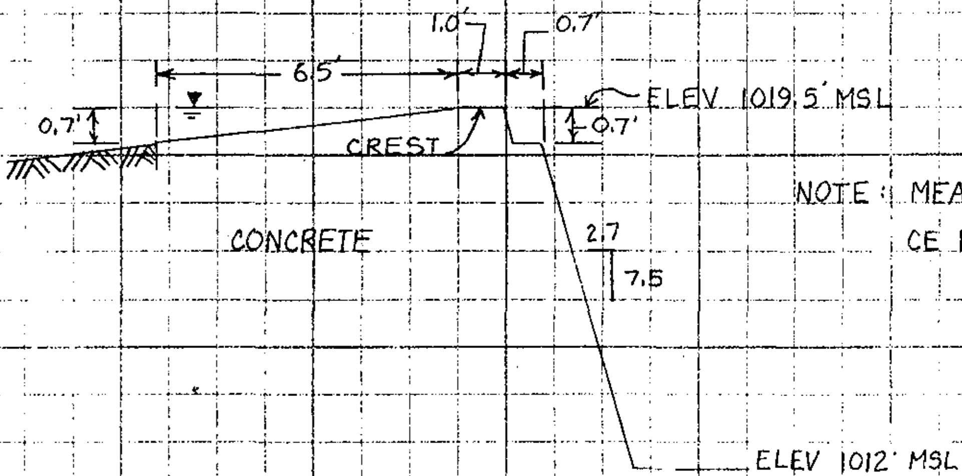
a) PEAK INFLOW = Q_{P_1} = 1250 CFS Q'_{P_1} = 2500 CFS

b) SPILLWAY (OUTFLOW) RATING CURVE

THE SPILLWAY IS A BROAD CRESTED WEIR, APPROXIMATELY 45' LENGTH, AND THE WIDTH AT THE CREST (ELEV 1019.5' MSL) IS 1.0 FOOT. (SEE DIAGRAM PG. 4) A CONCRETE APRON EXTENDS FROM THE BOTTOM OF THE SPILLWAY TO A 60" A.C.CMP. IN CONN ROUTE 263 ROAD EMBANKMENT. THE INVERT OF THE PIPE IS ELEV 1008 MSL (D/S TOE OF DAM). THE HIGHWAY EMBANKMENT/CULVERT WILL SIGNIFICANTLY CONTROL THE PEAK OUTFLOW FROM THE SPILLWAY TO SUCKER BROOK. HOWEVER, BECAUSE THE STRUCTURAL ABILITY OF THIS EMBANKMENT TO WITHSTAND A HIGH SURCHARGE IS UNKNOWN AND BECAUSE THE CULVERT COULD BE MODIFIED AT ANY TIME, THE DAM WILL BE ANALYZED AS IF THE HIGHWAY EMBANKMENT DID NOT EXIST.

CRYSTAL LAKE DAM

3b- CONT'D) SPILLWAY OUTFLOW RATING CURVE



NOTE: MEASUREMENTS TAKEN BY CE FIELD SURVEY, 08/79

∴ SPILLWAY COEFFICIENT, ASSUME $C = 3.2$

USING THE CREST ELEV AS DATUM (ELEV 1019.5 MSL) THE SPILLWAY DISCHARGE IS APPROXIMATED BY

$$Q_s = 3.2(45)H^{3/2} = 144H^{3/2}$$

ii) EXTENSION OF RATING CURVE FOR SURCHARGE HEADS ABOVE TO. OF DAM

THE DAM IS AN EARTHFILL DAM OF VARYING TOP WIDTH, THE TOP OF DAM ELEVATION BEING 1021.5 MSL. THE U/S FACE SLOPES 3^H TO 1^V TO (±) ELEV 1019.5 MSL, AND THEN RISES SHARPLY TO ELEV 1021.5 MSL. (SEE OVERTOPPING PROFILE FOR DAM AND ADJACENT TERRAIN ON PAGE 7)

CRYSTAL LAKE DAM

3b CONT'D) OUTFLOW RATING CURVE

ASSUME $C = 3.0$ FOR THE EARTH EMBANKMENT OVERFLOW
$C = 2.8$ FOR SIDES OF DAM OVERFLOW

ASSUME, ALSO, EQUIVALENT LENGTHS FOR THE EMBANKMENT AND SLOPING TERRAIN AT THE SIDES OF THE DAM AS FOLLOWS (SEE PG 7)

a) DAM EMBANKMENT $Q_D = (3)(180)(H-2)^{3/2} = 1140(H-2)^{3/2}$

$L_{DR} = 2/3\,(160/3)(H-2)^{5/2} = 35.6(H-2)^{5/2}$ (FOR $H < 5$) ; $Q_{DR} \doteq 106.7(H-2)^{5/2}$

$L'_{DR} = 160(H-h_o)^{3/2}$ FOR $H \geq 5$; $Q'_{DR} = 480(H-h_o)^{3/2}$

$Q'_{DR} = Q_{DR}$ WHEN $H = 5$ $\therefore$ $480(5-h_o)^{3/2} \doteq 550$

$(5-h_o) = (550/480)^{2/3} = 1.10$ $\therefore$ $h_o = 3.9$; $\therefore$ $Q'_{DR} = 480(H-3.9)^{3/2}$

b) TERRAIN

$L'_R = 2/3\,(65/8.3)(H-5)^{5/2} \doteq 5.2(H-5)^{5/2}$ $\therefore$ $Q'_R \doteq 14.6(H-5)^{5/2}$

$L'_L = 2/3(2)(H-2)^{5/2} \doteq 1.3(H-2)^{5/2}$ $\therefore$ $Q'_L \doteq 3.7(H-2)^{5/2}$

THE TOTAL OVERFLOW RATING CURVE CAN BE APPROXIMATED BY

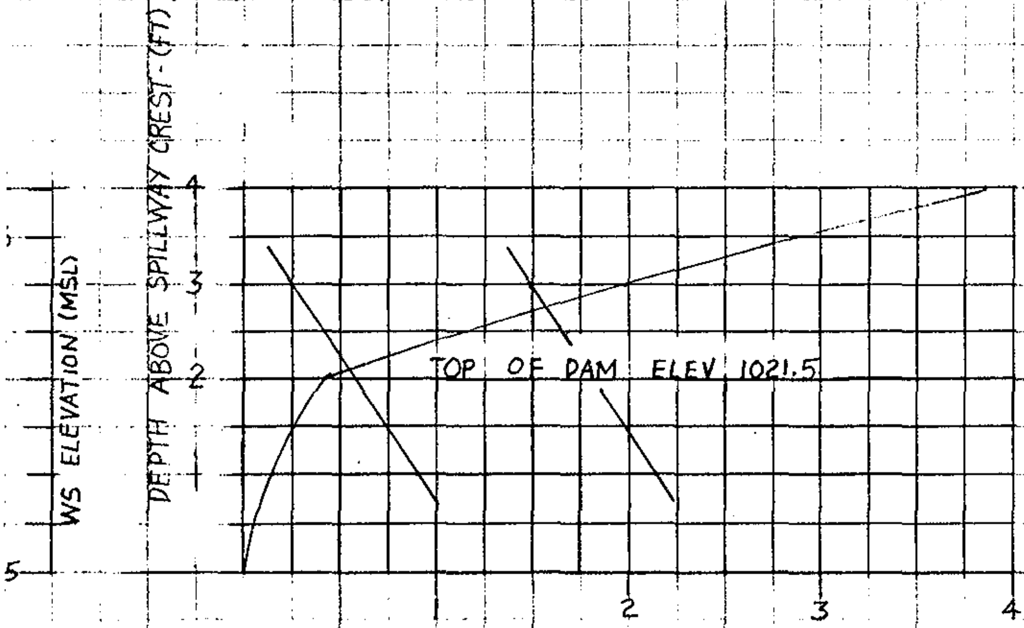
$Q \doteq Q_S + (Q_{DR} \text{ or } Q'_{DR}) + Q'_R + Q'_L + Q_D$

THE OUTFLOW RATING CURVE IS PLOTTED ON THE NEXT PAGE

*TEST FLOOD = ½PMF IN LIEU OF FULL PMF.

CRYSTAL LAKE DAM

3-(CONT'D) OUTFLOW RATING CURVE



c) SPILLWAY CAPACITY TO TOP OF DAM

$H = 2.0$ $Q_s \approx 410$ CFS (($\pm$)32% OF Q_{P_1}, ($\pm$) 16% OF Q'_{P_1})

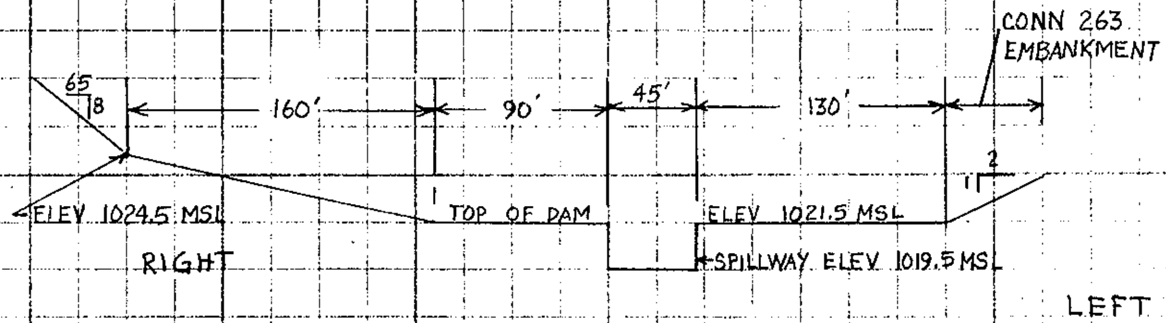
d) SURCHARGE HEIGHT TO PASS Q_{P_1}

i) @ $Q_{P_1} \approx 1250$ CFS : ½PMF $H_1 \approx 2.6$

ii) @ $Q'_{P_1} \approx 2500$ CFS = PMF $H'_1 \approx 3.2$

CRYSTAL LAKE DAM

3-(CONT'D) OUTFLOW RATING CURVE



4) EFFECT OF SURCHARGE STORAGE ON MAX. PROBABLE DISCHARGE

a) RESERVOIR AREA @ FLOW LINE * A_0 = 135 Ac
USE 150Ac AS SA. FOR RANGE OF EXPECTED SURCHARGE

b) ASSUME NORMAL POOL LEVEL @ SPILLWAY CREST (ELEV 1019.5 MSL)

c) WATERSHED AREA D.A. = 1.10 Sq. Mi.

d) DISCHARGE (Q_B) AT VARIOUS SURCHARGE ELEVATIONS

H = 1' V = 1 × 150 = 150 Ac·ft S = 150/(1.1 × 53.3) = 2.6"

H = 3' V = 3 × 150 = 450 Ac·ft S = 450/(1.1 × 53.3) = 7.7"

∴ FROM APPROXIMATE ROUTING NED-ACE GUIDELINES (19" MAX PROBABLE IN NEW ENGLAND :

* STATE OF CONN., HIGHWAY DEPT., S.A. = 135 Ac; CE MEASURE FROM USGS WINSTED QUADRANGLE S.A. = 135 Ac (1019.5 MSL); WINSTED DEPT OF PUBLIC WORKS SA = 146 Ac.

*TEST FLOOD = ½ PMF IN LIEU OF FULL PMF.

CRYSTAL LAKE DAM

4-CONT'D) EFFECT OF SURCHARGE STORAGE ON PEAK OUTFLOW

$Q_{P_2} = Q_{P_1}(1 - S/9.5)$ AND FOR 1/2 PMF $Q_{P_2}' = Q_{P_1}'(1 - S/19)$

∴ FOR

$H = 1'$ $Q_{P_2} \approx 900$ CFS $Q_{P_2}' \approx 2160$ CFS

$H = 3'$ $Q_{P_2} \approx 240$ CFS $Q_{P_2}' \approx 1500$ CFS

e) PEAK OUTFLOW (Q_{P_3})

USING NED-ACE GUIDELINES "SURCHARGE STORAGE ROUTING" ALTERNATE METHOD

$Q_{P_3} \approx 550$ CFS $H_3 \approx 2.1'$ FOR $Q_{P_1} = ½$PMF

$Q_{P_3}' \approx 1600$ CFS $H_3' \approx 2.8'$ FOR $Q_{P_1}' =$ PMF

f) SPILLWAY CAPACITY RATIO TO OUTFLOW

SPILLWAY CAPACITY TO TOP OF DAM $Q_S \approx 410$ CFS

∴ SPILLWAY CAPACITY IS (±) 75% OF OUTFLOW @ ½PMF AND (±) 26% OF THE OUTFLOW @ PMF

5) SUMMARY

a) PEAK INFLOW $Q_{P_1} = ½$PMF $= 1250$ CFS $Q_P' =$ PMF $= 2500$ CFS

*TEST FLOOD = ½ PMF IN LIEU OF FULL PMF. SEE TEXT

CRYSTAL LAKE DAM

5 CONT'D) SUMMARY

b) PEAK OUTFLOW $Q_{P_3} \cong 550$ CFS $Q_{P_3}' \cong 1600$ CFS

c) SPILLWAY MAX. CAPACITY $Q_S \cong 410$ CFS OR (±) 75% OF Q_{P_3} AND 26% OF Q_{P_3}'

THEREFORE, AT TEST FLOOD = ½ PMF; THE DAM IS OVERTOPPED (±)0.1' (WS ELEV 1021.6' MSL), OR, TO AN AVG SURCHARGE ABOVE THE SPILLWAY CREST OF (±) 2.1'

AT A FLOOD EQUAL TO FULL PMF, THE DAM IS OVERTOPPED (±) 0.8' (WS ELEV 1022.3 MSL) OR, TO AN AVG SURCHARGE ABOVE THE SPILLWAY CREST OF (±) 2.8'

APPROXIMATELY 50' D/S FROM CRYSTAL LAKE DAM, A 120' LONG 60" ACCMP CARRIES THE SUCKER BROOK FLOW THROUGH THE EMBANKMENT FOR CONN ROUTE 263. THE INLET IS AT AT ELEV 1008 MSL WHILE THE OUTLET IS AT ELEV 1004 MSL. ASSUMING THE MAN MADE EMBANKMENT COULD WITHSTAND THE SURCHARGE AND NOT FAIL, THE PEAK OUTFLOW D/S FROM ROUTE 263 WOULD BE AT ½ PMF AND PMF, $Q_{P_3} = 340$ CFS AND $Q_{P_3}' = 380$ CFS, RESPECTIVELY. THE CORRESPONDING SURCHAGES ABOVE THE SPILLWAY CREST WOULD BE (±) 3.7' (WS ELEV 1023.2 MSL) AND (±) 7.4' (WS ELEV 1026.9 MSL).

CRYSTAL LAKE DAM

II) DOWNSTREAM FAILURE HAZARD (ASSUMING HWGY EMBANKMENT REMOVED OR FAILED - SEE NOTE PG 11)

1) PEAK STAGE AND FLOOD IMMEDIATELY D/S FROM DAM

a) BREACH WIDTH

i) MID-HEIGHT* (±) ELEV 1015' MSL $(1021.5 - 14/2 = 1014.5$, SAY 1015')

ii) APPROX. MID-HEIGHT LENGTH $\ell_N = 230'$

iii) BREACH WIDTH (SEE NED-ACE D/S DAM FAILURE GUIDELINES)

$W = 0.40 \times 230 = 90'$ ASSUME $W_b \approx 90'$

b) PEAK FAILURE OUTFLOW

ASSUME SURCHARGE TO TOP OF DAM; THEREFORE,

i) HEIGHT OF DAM AT TIME OF FAILURE $Y_o = 14'$

ii) SPILLWAY DISCHARGE 410 CFS (SEE ITEM 4f PAGE 8)

iii) BREACH OUTFLOW

$$Q_b = (8/27) W_b \sqrt{g}\, Y_o^{3/2} \approx 7900 \text{ CFS}$$

*THE HEIGHT OF THE DAM IS DETERMINED FROM THE D/S TOE (INV. 60" ACCM UNDER A RECONSTRUCTED PORTION OF CONN. RT 263 (ELEV 1008 MSL)) TO TOP OF DAM (ELEV 1021.5 MSL); H = 13.5', SAY 14'
SEE DWGS. BY STATE OF CONN HIGHWAY DEPT., "REPLACEMENT OF BRIDGE AND APPROACHES OVER SUCKER BROOK ON ROUTE 263" 1976

hn Engineers Inc. Consulting Engineers

NON-FEDERAL DAM INSPECTION Sheet 11 of 12

By R.R.J. Checked By HEW JAC Date 08/07/79

Job Ref. Other Refs. CE #27660KC Revisions

CRYSTAL LAKE DAM

1b CONT'D) PEAK FLOOD AND STAGE IMMEDIATELY D/S FROM DAM

iv) PEAK OUTFLOW $Q_P = Q_s + Q_b = 410 + 7900 \approx 8300$ CFS

c) RAISE IN STAGE ABOVE TAILWATER IMMEDIATELY D/S FROM DAM

$Y = 0.44 Y_0 = 0.44(14) \approx 6.2'$

THE CHANNEL JUST D/S FROM THE DAM IS ON A SLOPE OF APPROXIMATELY 1.2%, DROPPING (±) 26^V IN A DISTANCE OF (±) 2200^H. THE TERRAIN SLOPES APPROXIMATELY 8^H TO 1^V TO THE RIGHT AND 7^H TO 1^V TO THE LEFT OF THE CHANNEL.

CRYSTAL LAKE DAM

1d) APPROXIMATE STAGE JUST BEFORE FAILURE

i) $Q = Q_s = 410$ CFS

* ii) STAGE FOR Q_s $Y_s \approx 3.4'$ FOR $Q_s \approx 410$ CFS

e) FLOOD STAGE AFTER FAILURE AT CHANNEL (±) 2700" D/S FROM DAM (IMMEDIATE IMPACT AREA

$Y_p \approx 10.6'$ FOR $Q_p \approx 8300$ CFS

f) RAISE IN STAGE IN IMMEDIATE IMPACT AREA

$\Delta Y = Y_p - Y_s \approx 7.2'$

2) SUMMARY

a) PEAK FAILURE OUTFLOW $Q_p \approx 8300$ CFS

b) RAISE IN STAGE JUST D/S FROM DAM $Y = 0.44\% \approx 6.2'$

c) APPROXIMATE STAGE JUST BEFORE FAILURE $Y_s \approx 3.4'$

d) APPROXIMATE STAGE AFTER FAILURE AT IMMEDIATE IMPACT AREA

$Y_p = 10.6'$

e) RAISE IN STAGE ; $\Delta Y = 7.2'$

PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATIONS

New England Division
Corps of Engineers

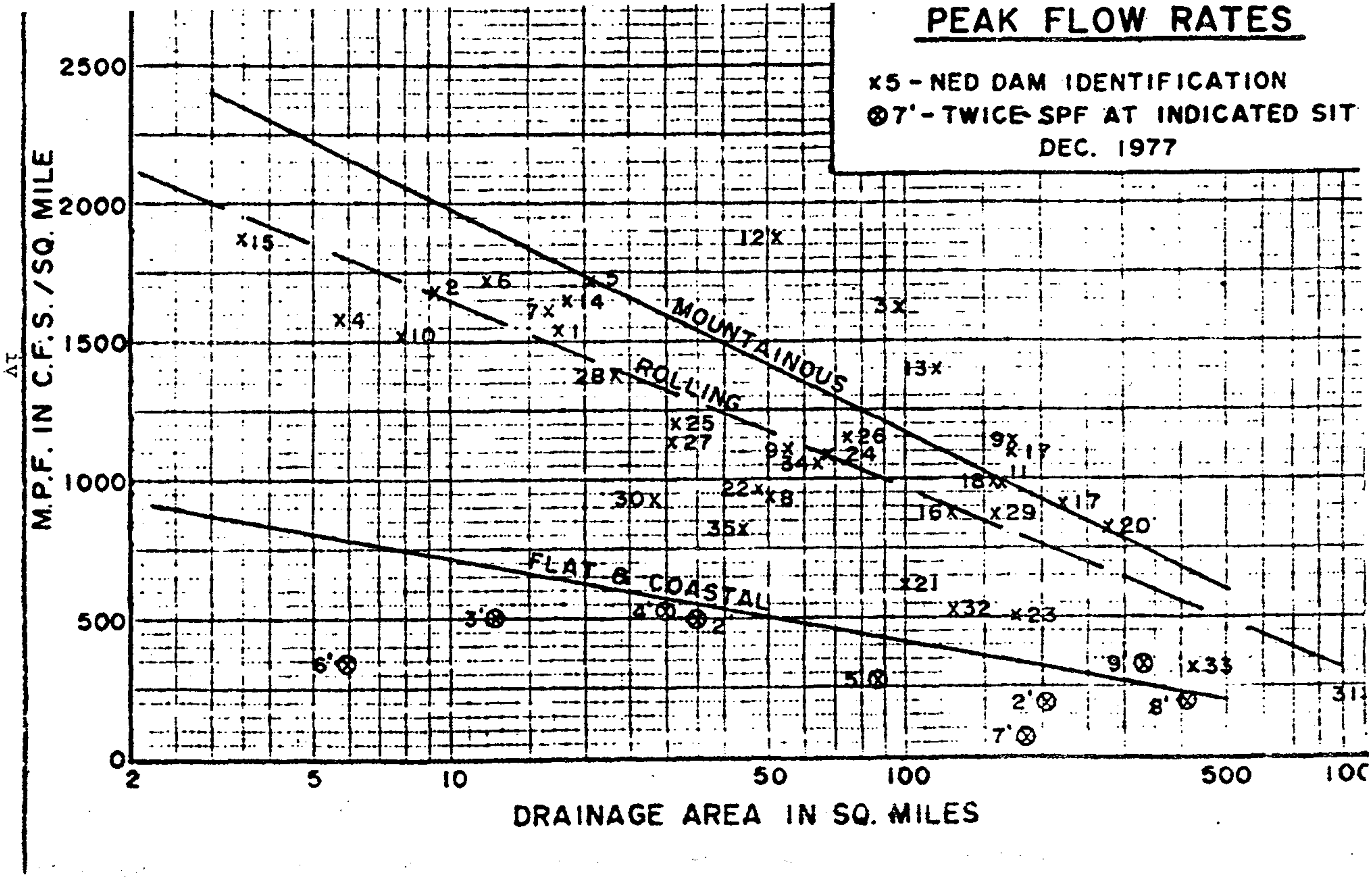
March 1978

MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

Project	Q (cfs)	D.A. (sq. mi.)	MPF cfs/sq. mi.
Hall Meadow Brook	26,600	17.2	1,546
East Branch	15,500	9.25	1,675
Thomaston	158,000	97.2	1,625
Northfield Brook	9,000	5.7	1,580
Black Rock	35,000	20.4	1,715
Hancock Brook	20,700	12.0	1,725
Hop Brook	26,400	16.4	1,610
Tully	47,000	50.0	940
Barre Falls	61,000	55.0	1,109
Conant Brook	11,900	7.8	1,525
Knightville	160,000	162.0	987
Littleville	98,000	52.3	1,870
Colebrook River	165,000	118.0	1,400
Mad River	30,000	18.2	1,650
Sucker Brook	6,500	3.43	1,895
Union Village	110,000	126.0	873
North Hartland	199,000	220.0	904
North Springfield	157,000	158.0	994
Ball Mountain	190,000	172.0	1,105
Townshend	228,000	106.0(278 total)	820
Surry Mountain	63,000	100.0	630
Otter Brook	45,000	47.0	957
Birch Hill	88,500	175.0	505
East Brimfield	73,900	67.5	1,095
Westville	38,400	99.5(32 net)	1,200
West Thompson	85,000	173.5(74 net)	1,150
Hodges Village	35,600	31.1	1,145
Buffumville	36,500	26.5	1,377
Mansfield Hollow	125,000	159.0	786
West Hill	26,000	28.0	928
Franklin Falls	210,000	1000.0	210
Blackwater	66,500	128.0	520
Hopkinton	135,000	426.0	316
Everett	68,000	64.0	1,062
MacDowell	36,300	44.0	825

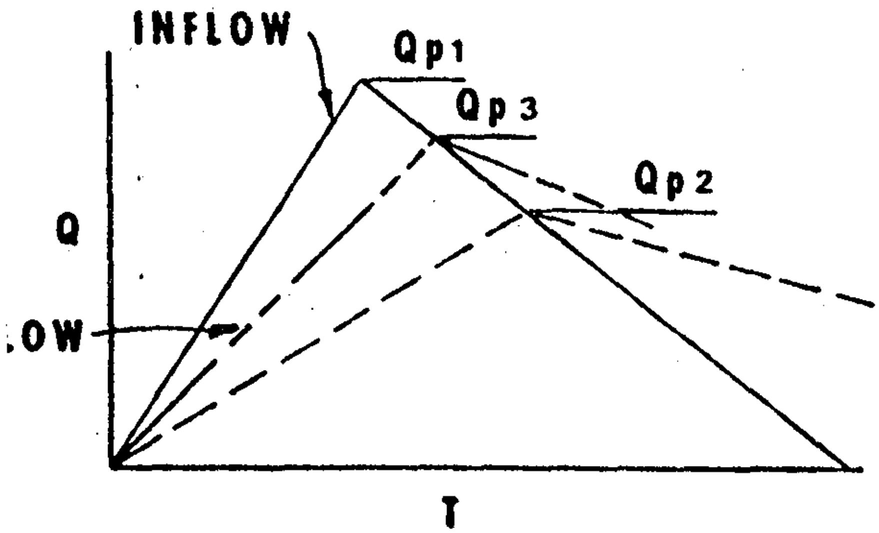
MAXIMUM PROBABLE FLOWS BASED ON TWICE THE STANDARD PROJECT FLOOD (Flat and Coastal Areas)

	River	SPF (cfs)	D.A. (sq. mi.)	MPF (cfs/sq. mi.)
1.	Pawtuxet River	19,000	200	190
2.	Mill River (R.I.)	8,500	34	500
3.	Peters River (R.I.)	3,200	13	490
4.	Kettle Brook	8,000	30	530
5.	Sudbury River.	11,700	86	270
6.	Indian Brook (Hopk.)	1,000	5.9	340
7.	Charles River.	6,000	184	65
8.	Blackstone River.	43,000	416	200
9.	Quinebaug River	55,000	331	330



PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SIT
DEC. 1977
M.P.F. IN C.F.S./SQ. MILE
DRAINAGE AREA IN SQ. MILES
MOUNTAINOUS
ROLLING
FLAT & COASTAL

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Q_{p1}) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Q_{p1}".

b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Q_{p2}"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Q_{p3}".

SURCHARGE STORAGE ROUTING SUPPLEMENT

EP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Avg "$STOR_1$" and "$STOR_2$" and Compute "Qp_3".

c. If Surcharge Height for Qp_3 and "$STOR_{AVG}$" agree O.K. If Not:

EP 4: a. Determine Surcharge Height and "$STOR_3$" To Pass "Qp_3"

b. Avg. "Old $STOR_{AVG}$" and "$STOR_3$" and Compute "Qp_4"

c. Surcharge Height for Qp_4 and "New $STOR_{Avg}$" should Agree closely

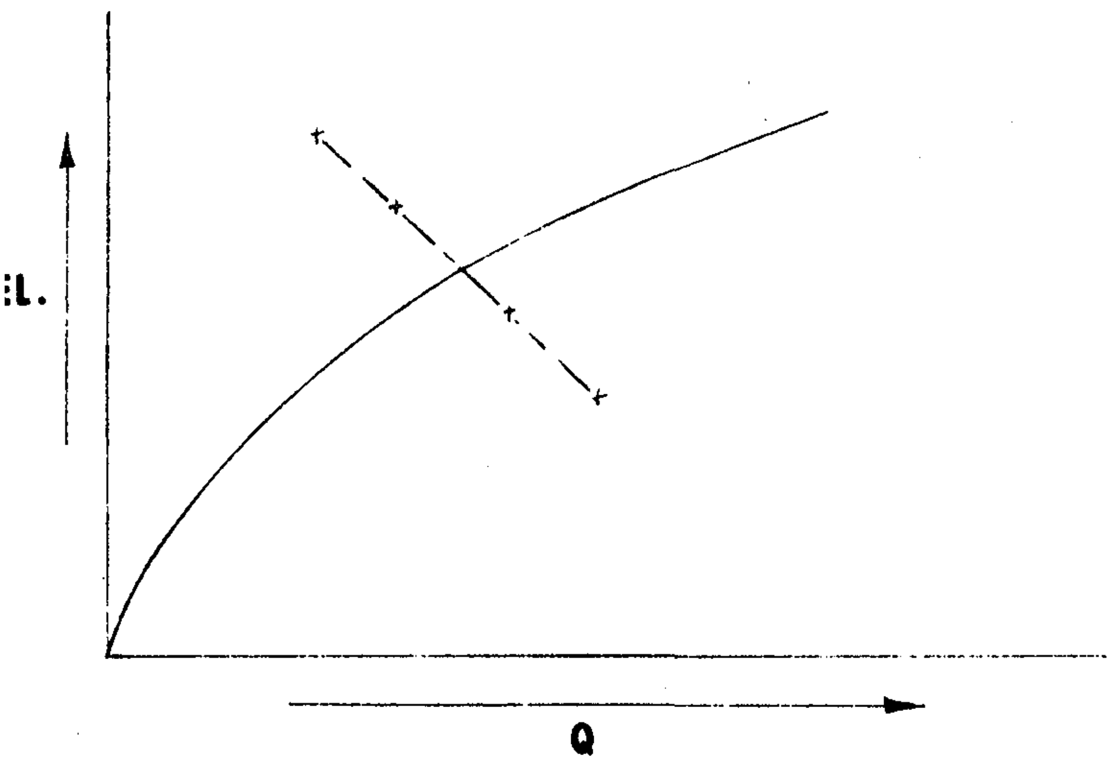
SURCHARGE STORAGE ROUTING ALTERNATE

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR}{19}\right)$$

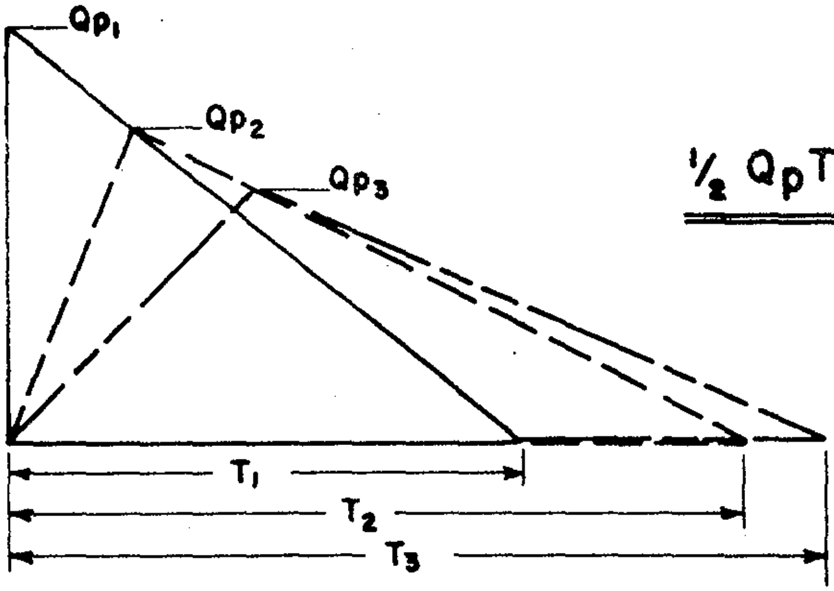
$$Q_{p2} = Q_{p1} - Q_{p1}\left(\frac{STOR}{19}\right)$$

FOR KNOWN Q_{p1} AND 19" R.O.

Q_{p2}	STOR	EL.



ULE OF THUMB" GUIDANCE FOR ESTIMATING OWNSTREAM DAM FAILURE HYDROGRAPHS



$$\frac{1}{2} Q_p T = 12\,S$$

TEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

TEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Qp_1 = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_o = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

TEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

TEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOPMANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Qp_2(\text{TRIAL}) = Qp_1\left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Qp_2 = Qp_1\left(1 - \frac{V_{AVG}}{S}\right)$$

TEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE (1)	IDENTITY NUMBER (2)	DIVISION (3)	STATE (4)	COUNTY (5)	CONGR. DIST. (6)	STATE (7)	COUNTY (8)	CONGR. DIST.	NAME (9)	LATITUDE (NORTH) (10)	LONGITUDE (WEST) (11)	REPORT DATE DAY MO YR (12)
CT	104	NED	CT	005	06				CRYSTAL LAKE DAM	4155.0	7306.3	31AUG79

POPULAR NAME (13)	NAME OF IMPOUNDMENT (14)
	CRYSTAL LAKE

REGION (15)	BASIN (16)	RIVER OR STREAM (17)	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE (18)	DIST FROM DAM (MI.) (19)	POPULATION (20)
01	08	SUCKER BROOK	BURRVILLE	2	2000

TYPE OF DAM (21)	YEAR COMPLETED (22)	PURPOSES (23)	STRUCTURAL HEIGHT (FT.) (24)	HYDRAULIC HEIGHT (FT.) (25)	IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.) (26)	IMPOUNDING CAPACITIES NORMAL (ACRE–FT.) (27)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
REPG	1892	S	14	14	1680	1400	NED	N	N	N	N	

REMARKS (28)

D/S HAS (29)	SPILLWAY CREST LENGTH (30)	SPILLWAY TYPE (31)	SPILLWAY WIDTH (FT.) (32)	MAXIMUM DISCHARGE (FT.) (33)	VOLUME OF DAM (CY) (34)	POWER CAPACITY INSTALLED (MW) (35)	POWER CAPACITY PROPOSED (MW) (36)	NAVIGATION LOCKS NO. (37)	LENGTH (FT.) (38)	WIDTH (FT.) (39)	LENGTH (FT.) (40)	WIDTH (FT.) (41)	LENGTH (FT.) (42)	WIDTH (FT.) (43)	LENGTH (FT.) (44)	WIDTH (FT.) (45)
2	520	U	45	410												

OWNER (46)	ENGINEERING BY (47)	CONSTRUCTION BY (48)
TOWN OF WINCHESTER	UNKNOWN	UNKNOWN

REGULATORY AGENCY DESIGN (49)	CONSTRUCTION (50)	OPERATION (51)	MAINTENANCE (52)
CT WATER RESOURCES	CT WATER RESOURCES	CT WATER RESOURCES	CT WATER RESOURCES

INSPECTION BY (53)	INSPECTION DATE DAY MO YR (54)	AUTHORITY FOR INSPECTION (55)
CAHN ENGINEERS INC	03MAY79	PL 92-367

REMARKS (56)